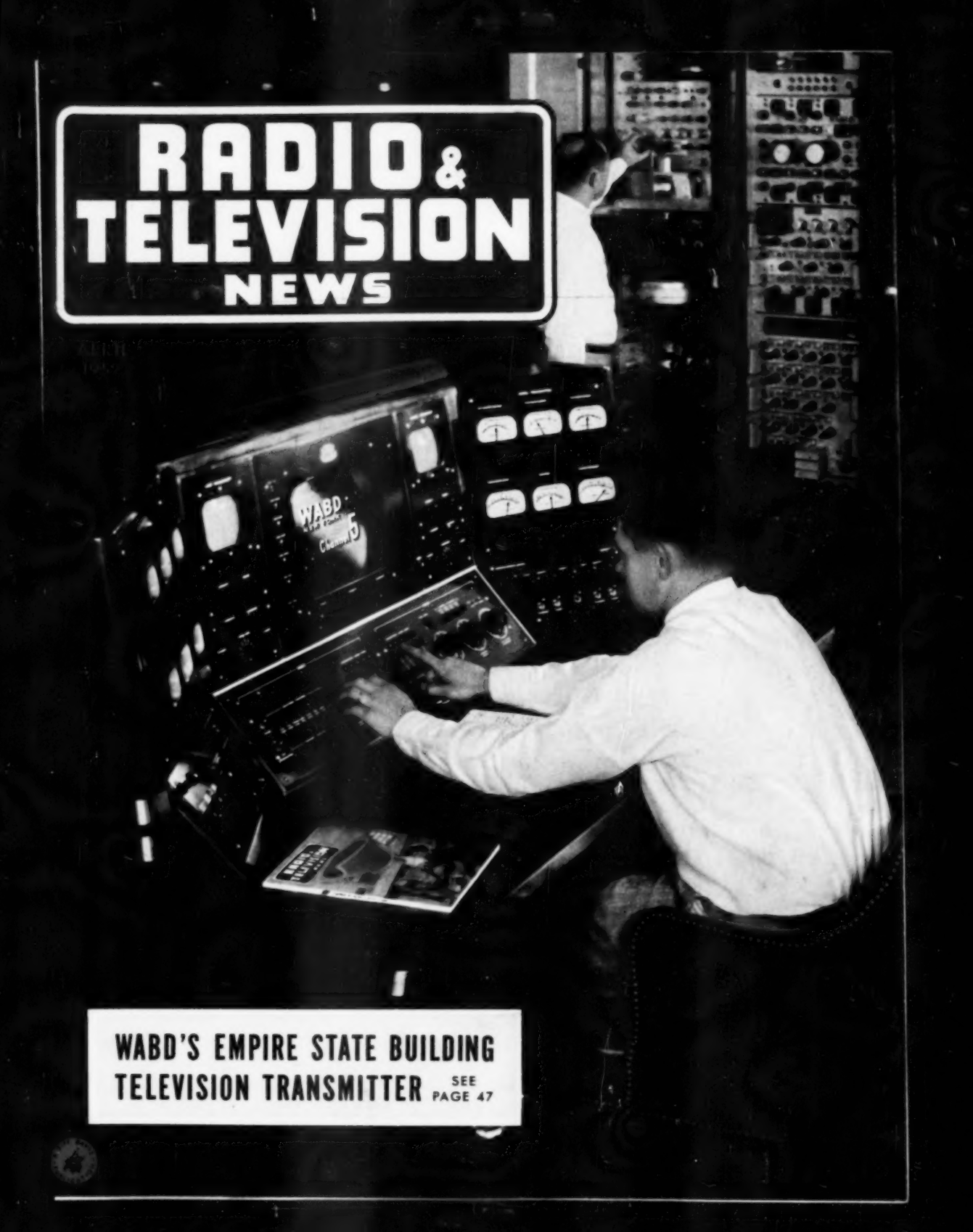
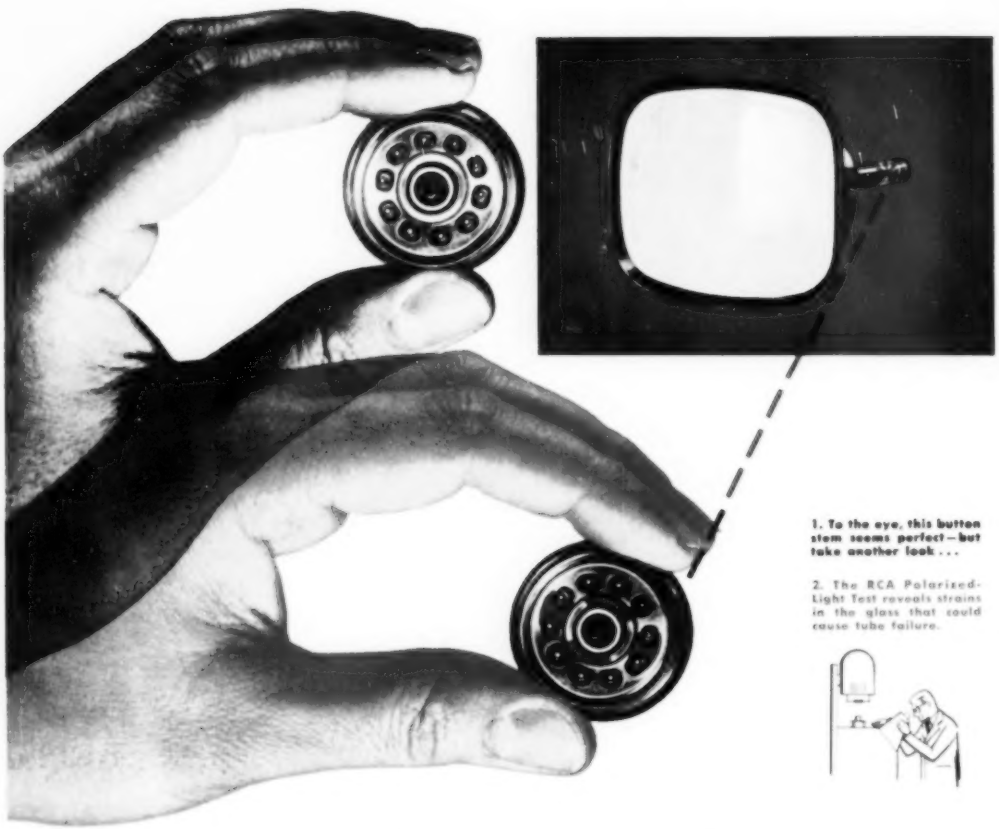
RADIO & TELEVISION NEWS



WABD'S EMPIRE STATE BUILDING TELEVISION TRANSMITTER SEE PAGE 47



1. To the eye, this button stem seems perfect—but take another look . . .

2. The RCA Polarized-Light Test reveals strains in the glass that could cause tube failure.

A *DOUBLE-TAKE*

to safeguard your reputation

AT FREQUENT INTERVALS throughout the day, RCA production inspectors pick finished button stems hot off the griddles of the sealing machines, and subject them to an ingenious "polarized-light test." Reason? Even slight variations in sealing temperature can, and do, set up strains in the areas of glass-to-glass and glass-to-metal seals that could result in fractures. The Polarimeter . . . especially designed for RCA . . . reveals these otherwise invisible strains, and prevents imperfect assemblies from reaching the final production line.

By taking a second look, RCA virtually licks a possible fracture before it occurs . . . not only on button stems, but also neck-to-flare seals and the faceplate section adjacent to the rim seal of metal-shell picture tubes.

This constant vigilance and *quality control* at *all* stages of manufacture assure that RCA standards will be met on the final assembly line. In this way, RCA closely guards its own reputation for quality . . . *and yours as well.*

In RCA picture tubes, the difference is *top-quality control.* That's why, dollar for dollar, RCA picture tubes have no equal.

With RCA Receiving Tubes, as well as RCA Kinescopes, TOP-QUALITY CONTROL makes the difference.

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"Have my own shop. Am authorized serviceman for five manufacturers and do servicing for 3 dealers."—P. MILLER, Maumee, O.

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COVER PHOTO: The master control console at WABD's new television studio in the Empire State Bldg., New York. WABD is one of five stations using the Empire State TV tower. (Kodachrome by Ed Padykula)

VOLUME 47 • NUMBER 4

Member Audit Bureau of Circulations

Editorial and Executive Offices, 366 Madison Ave., New York 17, N. Y.

RADIO & TELEVISION NEWS is published monthly by the Ziff-Davis Publishing Company at 185 N. Wabash Ave., Chicago 1, Illinois. Entered as second-class matter July 21, 1948, at the Post Office, Chicago, Ill., under the act of March 3, 1879. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Postmaster—Please return undelivered copies under form 3579 to 64 E. Lake St., Chicago 1, Ill.

SUBSCRIPTION RATES. RADIO & TELEVISION NEWS—in U.S., Canada, Mexico, South and Central America, and U.S. Possessions, $4.00 for twelve issues, in British Empire, $5.00; all other foreign countries, $5.00 for twelve issues. RADIO-ELECTRONIC ENGINEERING EDITION—in U.S., Canada, Mexico, South and Central America, and U.S. Possessions, $3.00 for twelve issues, in British Empire, $7.00; in all other foreign countries, $7.00 for twelve issues. SUBSCRIPTION SERVICE. All communications concerning subscriptions should be addressed to Circulation Dept., 64 E. Lake St., Chicago 1, Ill. Subscribers should allow at least two weeks for change of address.

CONTRIBUTIONS: Contributors are advised to retain a copy of their manuscripts and illustrations. Contributions should be mailed to the New York Editorial Office and must be accompanied by return postage. Contributions will be handled with reasonable care, but this magazine assumes no responsibility for their safety. Any copy accepted is subject to whatever adaptations and revisions are necessary to meet the requirements of this publication. Payment covers all author's, contributor's, and contestant's rights, title, and interest in and to the material accepted and will be made at our current rates upon acceptance. All photos and drawings will be considered as part of the material purchased.

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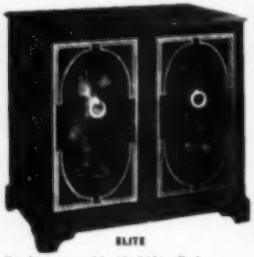

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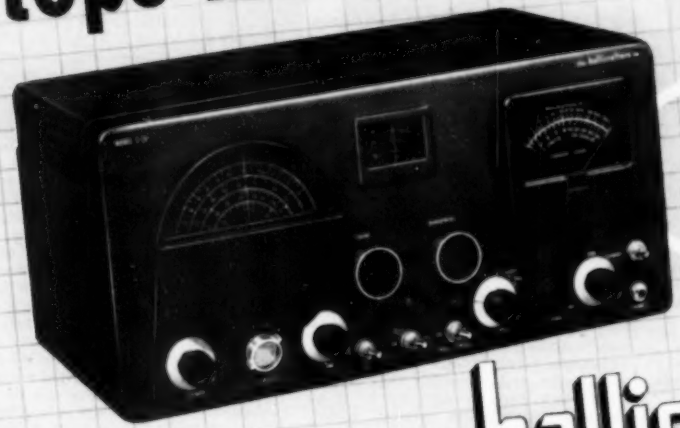

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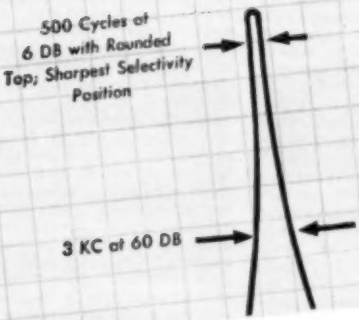

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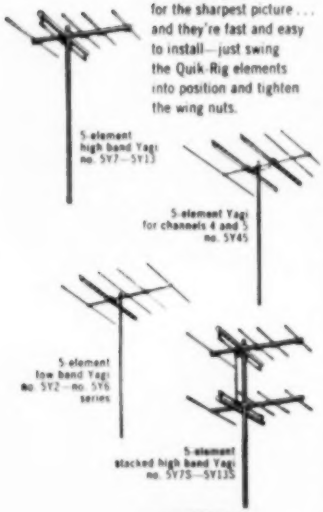
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For the RECORD.

BY THE EDITOR

THE AMAZING TRANSISTOR

FEW developments of recent years have served to stir the imagination as has the "junction transistor," announced by *Bell Laboratories* last year and described more fully on page 38. If this new device lives up to its advance notices, and there is every reason to believe that it will, it may well revolutionize the entire electronics industry.

This device removes many of the major objections to the more widespread use of vacuum tubes. It requires no heater power and only a very small amount of plate power, thus tremendously reducing the heat developed in equipment in which it is used, and also greatly simplifying power supply problems. It is practically indestructible, being capable of withstanding shocks and vibration that would completely destroy ordinary or even specially constructed vacuum tubes. There is no heater to burn out, no grid to short out, no cathode to fail; its life is practically unlimited. A life of 70,000 hours minimum has been suggested, and there is good reason to believe that such performance can be achieved and even exceeded.

There are other attributes of this amazing device which make it equal to or superior to conventional tubes, such as power gains of 50 db (100,000 times), and mutual conductances on the order of 30,000 micromhos per milliampere of current. Input and output impedances may be varied widely merely by altering connections. Plate circuit efficiency approaches very closely the theoretical limit of 50% for Class A and 100% for Class C operation, reducing the plate circuit power requirements well below those required for conventional tubes.

It would be well to insert a word of caution at this point. The junction transistor has some characteristics which limit its field of application, at least in the present state of development. For example, the maximum gain can be realized only at frequencies up to a few kilocycles, although useful gain as high as a megacycle or more has been achieved. Transistors are essentially low-power devices. One unit, having a cross-sectional area of about one square centimeter, has been built which is capable of producing an output of two watts, but conventional units are rated much lower. Another disadvantage which is being rapidly overcome is the difficulty encountered in mass-producing these items.

In spite of these disadvantages, the junction transistor is one of the most exciting developments to emerge from the research laboratories of this country in recent years. The characteristics of extreme ruggedness, long life, small size (about half the size of a pea), small power requirements, and high gain will permit the junction transistor to be used where heretofore conventional tubes were not even considered. Also, it is reasonable to believe that these units will replace vacuum tubes completely in many pieces of complex electronic equipment, such as electronic computers, and that they will be utilized in such applications as industrial electronic controls, controls in aircraft, and innumerable other locations where ruggedness, small size and reliability are paramount virtues.

One can foresee many military uses for this device, particularly in the field of proximity fuses and guided missiles. If the frequency response can be improved, and there is every reason to believe that it will be, its field of usefulness will be tremendously increased. Even in the present stage of development, it can be used along with the point-contact type of transistors, which have a frequency response up to 75 megacycles, and are now in mass production.

The junction transistor operates very satisfactorily at extremely low power levels. For example, Mr. R. L. Wallace at *Bell Laboratories* built an audio oscillator which operated satisfactorily with a power input of only 0.08 *micro*watt, provided by a power supply of 55 millivolts at 1.5 microamperes! Useful amplification is possible with input powers in this order of magnitude. It is thus conceivable that an amplifier or other electronic device could be built using this transistor which would last indefinitely, completely unattended, if powered by the new atomic battery recently announced, or some other long-life source of power.

Junction transistors are not available commercially at this time, and the point-contact type are available in only limited quantities. However, a great deal of effort is being spent in readying these devices for commercial applications, and it should not be too many months before small quantities will be available for experimental purposes, with full-scale production following very shortly.

It is highly improbable that the transistor will eventually replace the vacuum tube. It will, however, serve as a means of obtaining ultra compact and highly stable electronic devices for the home, for industry, and the military. . . . . O.R.

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New Pilot AF-605 Hi-Fi AM-FM Tuner

at a sensationally low price

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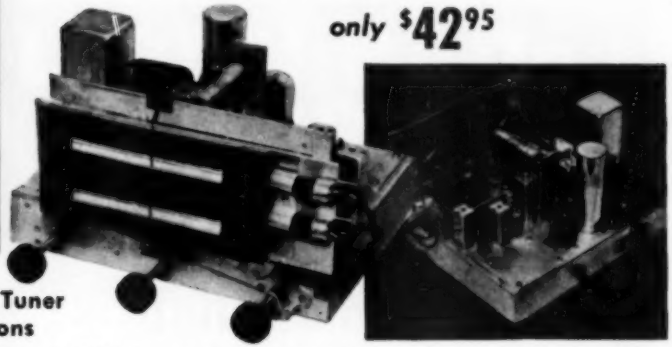

Lowest Cost High-Quality Tuner Ideal for Custom Installations

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FM Features: Tuned RF stage for maximum sensitivity and selectivity; built-in line; antenna temperature-compensated oscillator; ratio detector with 225 kc wide linear response; IF response 200 kc wide at 6 db points; 300 ohm balanced input to antenna coil with electro-static shield.

AM Features: Tuned RF stage; built-in high efficiency new "ceramic loop stick" iron-core antenna; IF wave trap; IF response 7.5 kc wide at 6 db points; separate diode for AVC voltage.

Pilot AF-605 Tuner Complete. Chassis size, 11½x6x9". For 110-120 volt, 50-60 cycle A.C. Complete with 9 miniature type tubes and rectifier. Shpg. wt., 8½ lbs.
97-944. *ALLIED'S low price only* **$42.95**

Best Buy IN A CUSTOM Hi-Fi AM-FM-Phono System

a complete top quality AM-FM-Phono System at low cost

Here's the special value ALLIED complete home entertainment system that provides superb reproduction from records as well as AM-FM broadcasts. The system includes (A) the famous KNIGHT 20-Watt High-Fidelity Amplifier with response ±1 db, 20-20,000 cps—unconditionally guaranteed for one full year; (B) the Pilot AF-605 FM-AM Tuner described above; (C) the General Electric S1201D 12" High-Fidelity Speaker with 14.5 oz. Alnico V magnet; (D) the Webster-Chicago 106-27 Three-Speed Automatic Record Changer with plug-in heads and 2 General Electric variable reluctance cartridges (one for standard records, one for LP records). The system is supplied complete, with all necessary cables and leads for interconnecting the components, plus all tubes, hardware and complete installation and operating instructions. Cables are equipped with plugs, ready to connect—no soldering required. Shpg. wt., 66 lbs. Here is a complete High-Fidelity system, unsurpassed for value, providing wide-range reproduction from records and AM-FM radio.

93-422. Complete AM-FM-Phono System. *ALLIED'S low price...* **$169.50**
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$..... enclosed. ☐ Full Payment ☐ Down Payment

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Electrons probe the future

1 Electron micrograph of an alloy of aluminum, nickel, cobalt and iron. Magnification 20,000 diameters.

2 Cooled from high temperature in a magnetic field, the alloy becomes a powerful, permanent magnet. Note changed structure. Black bars reveal formation of precipitate parallel to the applied field. Each bar is a permanent magnet.

3 A Bell scientist adjusts electron diffraction camera. Electrons are projected on the specimen at glancing angles. They rebound in patterns which tell the arrangement of the atoms . . . help show how telephone materials can be improved.

In 1927, Bell Laboratories physicists demonstrated that moving electrons behave like light waves, and thus launched the new science of electron optics.

Now, through the electron beams of the electron microscope and electron diffraction camera, scientists learn crucial details about the properties of metals far beyond the reach of optical microscopes or chemical analysis.

At the Laboratories, electron beams have revealed the minute formations which produce the vigor of the permanent magnets used in telephone ringers and magnetron tubes for radar. The same techniques help show what makes an alloy hard, a cathode emit more electrons and how germanium must be processed to make good Transistors.

This is the kind of research which digs deep *inside* materials to discover how they can be made better for your telephone system . . . and for the many devices which the Laboratories are now developing for national defense.

4 Diffraction pattern of polished germanium reveals minute impurities which would degrade the performance of a Transistor.

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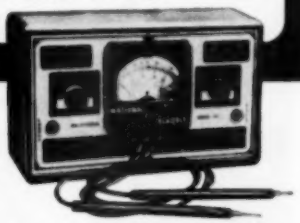

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You get this amazing, new testing instrument—factory-made and tested—complete—ready to use! Simple to operate. Accurate and dependable. An instrument every Radio-TV man needs. Light enough to carry around—so you can use it at home or on service calls. You'll be proud to own this valuable equipment.

Here are only a Few of the Good-Paying Jobs You Can Choose

Radio Station Engineer, District Service Manager, Aircraft Radio Inspector, Own Your Own Repair Shop, Inspector Technician, Service Specialist, Special Government Jobs, Complete TV Service, Sound Truck Operator, Many more!

National Schools graduates have secure, good-paying jobs like these! So don't wait—mail the coupon today. Now—while you're thinking about it!

Today's Shortage of Trained Technicians Creates Chance of a Lifetime For You!

Think of it! With guided missiles, radar, and other electronic devices so important to national defense! With big, new developments in TV. With over 90,000,000 home and auto radios, over 12,000,000 TV sets. With more than 3100 radio stations...over 100 TV stations—and more building every day...yes, imagine the great opportunity you have today!

YOU are wanted in Radio-Television-Electronics! America's fastest-growing field. High-pay jobs—the kind you've always wanted—are waiting for YOU!

Job Security! Big Money! For YOU! in Today's Expanding Industries!

Trained Radio and Television technicians really make important money these days. Thousands of National Schools graduates—men just like you—are earning good money all over the country. Why not you? And—National Schools graduates get the personal satisfaction of being highly-skilled technicians. Men people respect. Men who *enjoy* their work—rather than having to drag along in just any old job.

National Schools Has Trained 1000's of Successful Men! Why Not YOU?

In almost every state—and many foreign countries—National Schools graduates are filling big jobs with famous companies. Or running their own successful businesses. What are YOU waiting for? National Schools training is *complete* training. So when you graduate you can take advantage of today's big opportunities in Radio-Television-Electronics—fast.

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National Schools' course quickly prepares you for many important jobs in the Armed Services. With National Schools Training you have an opportunity to get into *special* service classifications—with higher pay and grade—immediately!

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National Schools uses its great influence and prestige to help you find your place in the field of your choice. Don't put it off! Start yourself toward a skilled trade! Get the big pay you've always wanted!

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Mail in envelope or paste on penny post card.

Mail me FREE the book mentioned in this ad. Also a free sample lesson. I understand no salesman will call on me.

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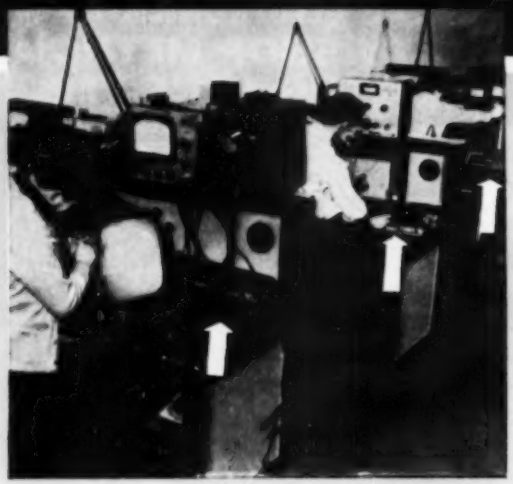
☐ Check here if you were released from the Service less than 4 years ago.

SAVE TUBES— WITH G.E.'S NEW



TUBESAVER

Says Al Mirus of Mirus TV Service Shop (left), 6579 Glenway Ave., Cincinnati, O.: "Our G-E Tubesavers do just what the name says. That's why we have one at every bench. A Tubesaver holds up to 52 tubes in their proper sequence, gripping the tubes so tightly they can't fall out. Built-in pin-straighteners help, too. The best and most practical device we've seen!"

NO MORE WORRY ABOUT PUTTING TUBES BACK IN THE WRONG SOCKETS!... The systematic layout of the G-E Tubesaver keeps tubes in their exact order. Moreover, they stay that way because rubber inserts keep them from dropping out—*even if you tip the Tubesaver sharply!* With its convenient handle design, the Tubesaver can be laid flat on the bench, angled, or hung on the wall nearby.

HOW YOU CAN TEST TUBES FAST AND ACCURATELY!... Place tubes in the inner holes of the G-E Tubesaver. Test them one-by-one. Put the good tubes in the outer set of holes, and return rejects to the inner set. Interruptions are no handicap—the Tubesaver keeps tubes correctly arranged till you resume work. *In their proper order* you now show the full tube complement of the receiver—which tubes are usable, which not!

SEE YOUR G-E TUBE DISTRIBUTOR FOR FULL DETAILS!

SAVE TIME-
SERVICE AIDS!

PICTURE-TUBE CARRIER

Here's a practical aid that enables you to carry a cartoned picture tube safely and easily with one hand, leaving the other free for service equipment. Heavy canvas straps—quickly adjusted—hold the tube carton firmly. Rounded leather grip fits snugly in the hand. Blue and yellow colors are attractive. Save extra steps with this new convenience!

DROP-CLOTH

Use this handy G-E drop-cloth to cover fine rugs or cabinets. It's durably woven, with a soft texture that won't harm the most delicate surface. A plastic top coating takes hard wear, resists hot solder, can be wiped clean in a jiffy. Customers will appreciate your protecting their furnishings from dust, grime, and stray particles of metal!

MAKE MORE CALLS PER DAY

... with these G-E-tube service aids! They cut time and costs, build customer goodwill. Your General Electric tube distributor will be glad to help you obtain them. Phone or write him today!

General Electric Company, Electronics Division, Schenectady 5, New York.

181-1A1

You can put your confidence in

GENERAL ELECTRIC

Here's your Opportunity

to prepare for a good job or a business of your own in TV SERVICING

There are today more good jobs open in TV Servicing than there are trained and experienced men to fill them. Yes, thousands of opportunities exist now for good-pay jobs offering employment security for years and years to come. Thousands of TV Servicing jobs are going begging. Do you want one of them?

Experts agree, that because of the critical shortage of trained and experienced TV Servicemen, and the tremendous future growth of the industry, no vocational field today offers more opportunities than TV Servicing.

The Big New Industry with a Great Future

Television is just in the beginning stages of its big industrial boom. Look at these amazing facts:

- Lifting the freeze on new TV stations will open many new TV areas and will improve the coverage of existing areas. The result will be an enormous demand for TV receivers.
- Within a few years over 1000 TV stations will be telecasting compared with 108 TV stations now on the air.
- Nearly one-half of all families living within the present TV areas do not yet own TV receivers.
- The new trans-continental video network plus better and more interesting programs plus larger viewing screens and color TV will increase the installation of new receivers, will induce present owners of 12-inch and smaller size viewing screens to buy newer model receivers.
- The power increases of many existing stations and improved reception range of current receivers will result in receivers being installed and serviced in the fringe areas of present stations.
- Under the FCC proposal, over 70 per cent of all communities will be served by UHF channels exclusively. This means TV servicemen must know UHF receivers before the new UHF stations in their area are opened.
- No one yet knows how great the industrial TV market will be.

RCA Institutes Home Study Course prepares you for a Career in TV Servicing

The addition of the RCA Institutes TV Service Training to your present radio-electronics experience will qualify you to step out and grasp the golden opportunities that now exist in television—America's fastest growing industry.

Learn at home—in your spare time—while you study the practical *how-to-do-it* techniques with *how-it-works* information. Easy-to-read and easy-to-understand lessons under the supervision of RCA engineers and experienced instructors quickly train you to qualify for the many good jobs now waiting for trained TV servicemen. Don't pass up this lifetime opportunity for financial security and a bright future in TV. Learn TV Servicing from RCA—pioneers and leaders in radio, television and electronic developments.

RCA Institutes conducts a resident school in New York City offering day and evening courses in Radio and TV Servicing, Radio Code and Radio Operating, Radio Broadcasting, Advanced Technology. *Write for free catalog on resident courses.*

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Mail the coupon—today. Get complete information on the RCA INSTITUTES Home Study Course in Television Servicing. Booklet gives you a general outline of the course by units. See how this practical home study course trains you quickly, easily. Mail coupon in envelope or paste on postal card.

MAIL COUPON NOW!

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Without obligation on my part, please send me copy of booklet "RCA INSTITUTES Home Study Course in TELEVISION SERVICING." (No salesman will call.)

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PRESENTING

COLLINS

AM-FM "PRE-FAB" TUNERS

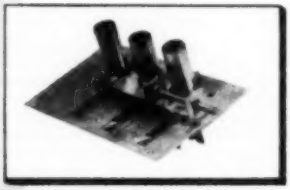
***NOW** you can build a Collins AM-FM tuner from the Pre-Fab units shown below!*

COMPLETE VERSATILITY is the byword in this new tuner design. Through the addition of the AM circuit, the Collins tuner will meet all requirements for home music systems and installations where a fine tuner is required.

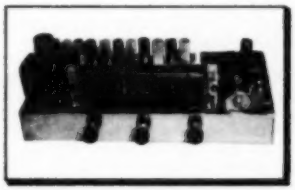
ECONOMY: The very finest in tuner design is offered you at exceptionally low prices, Collins quality is your assurance of a fine product that will work to your complete satisfaction. You cannot duplicate this tuner in its completed form at *twice the price!*

3 Ways to purchase COLLINS Tuner . . .

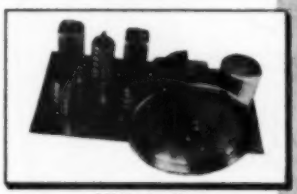
1. As an AM tuner kit
2. As an FM tuner kit
3. As an AM-FM tuner kit



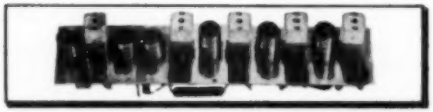
FM Tuning Unit **$15.25**



The Collins FM-AM Pre-Fab Tuner Kit As It Looks After You Assemble It. Total Kit Cost **$69.00)**



AM Tuning Unit (Includes IF and Audio Amplifier) **$19.25**



FM IF Amplifier **$19.75**

Tuning Eye Kit Available At **$2.85**

UC-2 Universal Chassis Kit **$14.75**

ALL PRE-FAB UNITS ARE ASSEMBLED, WIRED, TESTED, AND ALIGNED AT FACTORY. PRICES SHOWN INCLUDE TUBES.

The FM tuning unit employs a 6J6 dual triode RF amplifier, 6AG5 converter, and 6C4 oscillator. Permeability tuned, stable, and drift-free. High sensitivity of between 6 and 10 microvolts. Dimensions: 7¼"x4½". The IF amplifier for FM uses 6 tubes! 6BA6, (4) 6AU6, and 6AL5 discriminator. High gain, wide band response for highest fidelity reception. Frequency response of FM section, plus or minus 2 DB, 20 to 20,000 cycles. Distortion less than ½ of 1%. Dimensions: 11⅛"x2½".

The AM tuning unit utilizes a super-het circuit employing three tubes: 6BE6 converter, 6BA6 IF amplifier, and 6AT6 detector. Extremely high sensitivity and selectivity is accomplished through the use of new, high gain iron-core transformers. Careful alignment provides widest response available from this type of circuit. If builder desires, triode amplifier section of 6AT6 tube may be used as first audio stage.

Chassis Kit includes all necessary parts. Nothing else to buy! Instruction Manual included with detailed, step-by-step procedure, pictures and schematic diagrams. Chassis measures 8"x17"x 2½". Overall, the tuner, when assembled, measures 8"x17"x6".

MAIL ORDER COUPON TODAY!

TO: COLLINS AUDIO PRODUCTS CO. INC.
P.O. Box 368, Westfield, N.J.

Enclosed Find ☐ **Check** ☐ **Money Order For**

- ☐ AM Tuning Unit
- ☐ FM Tuning Unit
- ☐ FM IF Amplifier
- ☐ UC-2 Chassis Kit
- ☐ M-1 Tuning Eye Kit

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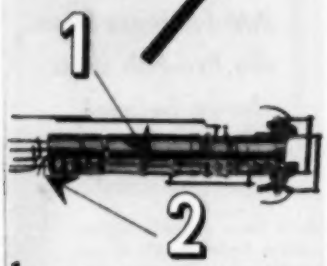
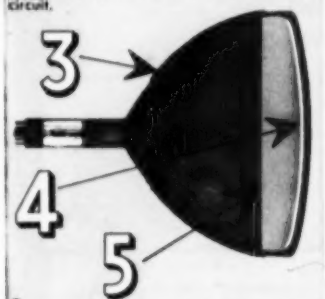
CITY_____ STATE_____

Six quality features of all Tung-Sol Picture Tubes mean better TV receiver operation



1. Glass bead type assembly is stronger, both mechanically and electrically—gives greater protection against leakages and arcing.

2. Double cathode tab provides double protection against failure in the cathode circuit.



3. Low resistance of outside conductive coating minimizes radiation of horizontal oscillator sweep frequency.

4. Fortified screen composition resists burning (X pattern).

5. Rigid control of internal conductive coating materially improves service reliability.

6 Tung-Sol Picture Tubes can be used with single or double field ion trap designs.

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Spot Radio News

** Presenting latest information on the Radio Industry.*

By RADIO & TELEVISION NEWS' WASHINGTON EDITOR

FCC's annual report to Congress, always a widely-read document, in its newest version, should become one of the most popular publications on Washington bookshelves. For in this edition, the seventeenth (fiscal year ending June 30, 1951), there appears a wealth of valuable information that countless persons in government and industry will find constantly useful throughout the year. Not only does the text disclose, in detail, developments in television and general broadcasting, but also advancements made in common-carrier services, which are described as being of equal concern to the public, since they help to protect life and property, aid commerce and industry, and provide employment, and other individual benefits.

Reviewing the progress achieved in aeronautical radio, the report states that expansion in this art has been extremely rapid. In 1938, the records show that there were less than 1500 aeronautical stations of all kinds. At the close of the fiscal year of '51, there were more than 34,000 authorized aircraft and ground stations, an increase due in part to the large growth of voluntary installations of communications equipment aboard private aircraft. Describing the assorted types of stations using radio communications, the Commission noted that there are many of a rather specialized nature in this category. There are, for instance, the airdrome control stations, which provide communications between the control tower and aircraft or aeronautical mobile utility stations for the purpose of controlling aircraft within the control area of an airport, as well as both aircraft and vehicular traffic on any portion of the landing area. This control is extremely important, in that it provides a means of directing arriving and departing traffic so as to maintain safe separation of planes to avoid collision. Also assured is an efficient flow of air traffic into and out of the airport. To date, there are fifty-six stations of this type operating throughout the country.

Mobile utility stations represent another special type of aviation communication service now in use. Over one-hundred are now used aboard crash, fire, and maintenance cars, operating in airdromes to provide contact with control towers. This service affords safety insurance for those in the planes, on the field, and in nearby communities.

Navigational type facilities were also described as vital in the aircraft-communication program, and thus far the Commission has authorized more than one-hundred-fifty stations for this purpose. Many types of aids are employed: radio beacons, radio direction finders, radio ranges, localizers, glide paths, marker beacons, ground-control approach, instrument landing, radar and distance measuring stations. The service is normally operated by the CAA. However, because of the use of off-airways-route operation by air carriers, it has become necessary for the carriers to establish and operate additional navigation facilities.

Flying-school stations were also found to be key users of radio facilities. According to the Commission's review, eighteen licenses were granted for this purpose to those who operate ground-air schools and require communications for flight instructions to students or pilots. Not only is this contact necessary for instruction, but for the promotion of safety of life and property. Flight testing stations were also noted as an active user of radio facilities, with over one-hundred such stations approved last year.

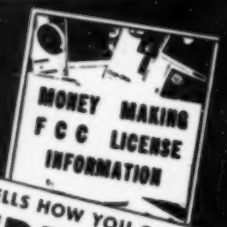
One of the largest users of radio, according to the Commission, is the public service stations, which provide communication between individuals aboard aircraft in flight and persons on the ground. Nearly five-hundred and fifty licenses have been released for this purpose.

During '51, a new type of station was also inaugurated; aeronautical advisory. It was authorized to meet an increasing demand for advisory air-ground communication at the smaller airdromes, many of them in remote locations not served by regular aeronautical control or communication facilities. Analyzing the services provided by these new stations, the annual review declares that they permit contact between an airport operator and private aircraft enabling pilots to ascertain the condition of the runways, type of fuel available, wind conditions, weather, and other information required for plane operation.

Railroad radio service was also reported to have really spread its wings. As of '51, the railroads had in excess of six-hundred authorizations covering

Want To Double Your Pay?

How To Pass FCC COMMERCIAL RADIO OPERATOR LICENSE EXAMINATIONS



TELLS HOW YOU CAN GET A FREE TELEVISION ENGINEERING COURSE

GET THIS AMAZING NEW BOOKLET FREE!

TELLS HOW—

WE GUARANTEE

TO TRAIN AND COACH YOU AT HOME IN SPARE TIME UNTIL YOU GET

YOUR FCC LICENSE

If you have had any practical experience—Amateur, Army, Navy, radio repair, or experimenting.

TELLS HOW— **Employers make**

JOB OFFERS Like These to Our Graduates Every Month!

Letter, October 11, 1951, from Chief Engineer, Broadcast Station, North Carolina. "Need man with radiotelephone 1st class licenses, no experience necessary. Will learn more than at average station for we are equipped with Diesel Electric power, transmitting and studio equipment."

Telegram, October 2, 1951, from Chief Engineer, Broadcast Station, Wyoming. "Please send latest list available first class operators. Have November 10th opening for two combo men."

Letter, October 8, 1951, from Chief Engineer, Broadcast Station, Texas. "Please send list of latest licensed graduates."

These are just a few examples of the job offers that come to our office periodically. Some licensed radioman filled each of these jobs . . . it might have been you!

HERE'S PROOF FCC LICENSES ARE OFTEN SECURED IN A FEW HOURS OF STUDY WITH OUR COACHING AT HOME IN SPARE TIME

Name and Address	License	Lessons
Lee Worthy, 2210½ Wilshire St., Bakersfield, Calif.	2nd Phone	16
Clifford E. Vogt, Box 1016, Dania, Fla.	1st Phone	28
Francis X. Foerch, 58 Boucher Pl., Bergenfield, N. J.	1st Phone	38
S. Sgt. Ben H. Davis, 317 North Roosevelt, Lebanon, Ill.	1st Phone	28
Albert Schoell, 110 West 11th St., Escondido, Calif.	2nd Phone	23

CLEVELAND INSTITUTE OF RADIO ELECTRONICS
Desk RN-40, 4900 Euclid Bldg., Cleveland 3, Ohio

TELLS HOW—

Our Amazingly Effective JOB-FINDING SERVICE Helps CIRE Students Get Better Jobs

Here are a few recent examples of Job-Finding results:

GETS CIVIL SERVICE JOB

"Thanks to your course I obtained my 2nd phone license, and am now employed by Civil Service at Great Lakes Naval Training Station as an Equipment Specialist."
Kenneth R. Leiser, Fair Oaks, Mrd. Del., McHenry, Ill.

GETS STATE POLICE JOB

"I have obtained my 1st class ticket (thanks to your school) and since receiving same I have held good jobs at all times. I am now Chief Radio Operator with the Kentucky State Police."
Edwin P. Healy, 264 E. 3rd St., London, Ky.

GETS BROADCAST JOB

OURS IS THE ONLY HOME STUDY COURSE WHICH SUPPLIES FCC-TYPE EXAMINATIONS WITH ALL LESSONS AND FINAL TESTS.

"I wish to thank your Job Finding Service for the help in securing for me the position of transmitter operator here at WCAE, in Pittsburgh."
Walter Koschik, 1442 Ridge Ave., N. Braddock, Pa.

GETS AIRLINES JOB

"Due to your Job-Finding Service, I have been getting many offers from all over the country, and I have taken a job with Capital Airlines in Chicago, as a Radio Mechanic."
Harry Clare, 4537 S. Drexel Blvd., Chicago, Ill.

Your FCC Ticket is recognized in all radio fields as proof of your technical ability.

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nearly four-hundred land stations and 5300 mobile units. Approximately fifty per-cent of the class 1 roads were said to employ such facilities for communication on and with trains en route and communication within yard and terminal areas. Forty-one frequencies in the 152-162 megacycle band have been allocated for the rail contacts.

In ham radio, one of the greatest spurts in interest was noted by the ether patrolmen. At the end of the fiscal year, there were approximately 90,500 amateur licenses and 88,700 operator licenses outstanding. The number of stations was said to be higher because many operators are licensees of more than one station, either as trustee-licensees of stations used by clubs or by military units, or as owners of personal stations at more than one address. There are, of course, many hams who do not have station licenses due principally to their being in the Armed Forces, or inability to locate a station at a permanent address.

Striking tribute to the talents of the hams appears within the Commission's report, in an extensive review of their achievements, not only during '51 but in other years. Commenting on the ability of the hams, the Commissioners said: "Through the exercise of their skills in designing, developing, constructing, and experimenting with radio equipment, and developing communication techniques, as well as by providing scientific observation services and emergency communication service in times of disaster or local emergency, and the handling of personal messages between members of the Armed Forces and their families at home, the amateurs have demonstrated that the privileges granted them have been well justified." Continuing, in a summarization of the national value of the amateur radio service, the report declares that the service . . . "constitutes a reserve of self-trained radio technicians and operators upon which the country can draw in times of war and other national need, and its special networks, equipment of its stations, and other amateur activities have proved extremely valuable in the national defense program. . . . In the planning for the defense of the civilian population in case of armed attack, the Federal Civil Defense Administration is encouraging the integration of amateur radio stations, operators, and networks into the local civil defense organizations to provide civil defense communication."

The value of the hams in times of emergency is also extolled in the report. One of the most outstanding examples of public service by the hams was cited as having occurred during the early part of '51, when severe storms blanketed a large portion of Texas for a period of over 170 hours, completely disrupting communication and power lines within that area. It was pointed out that . . . "communications handled by the amateurs in the area, using emergency power in many

(*Continued on page* 90)

RADIO-ELECTRONIC *Engineering* SECTION

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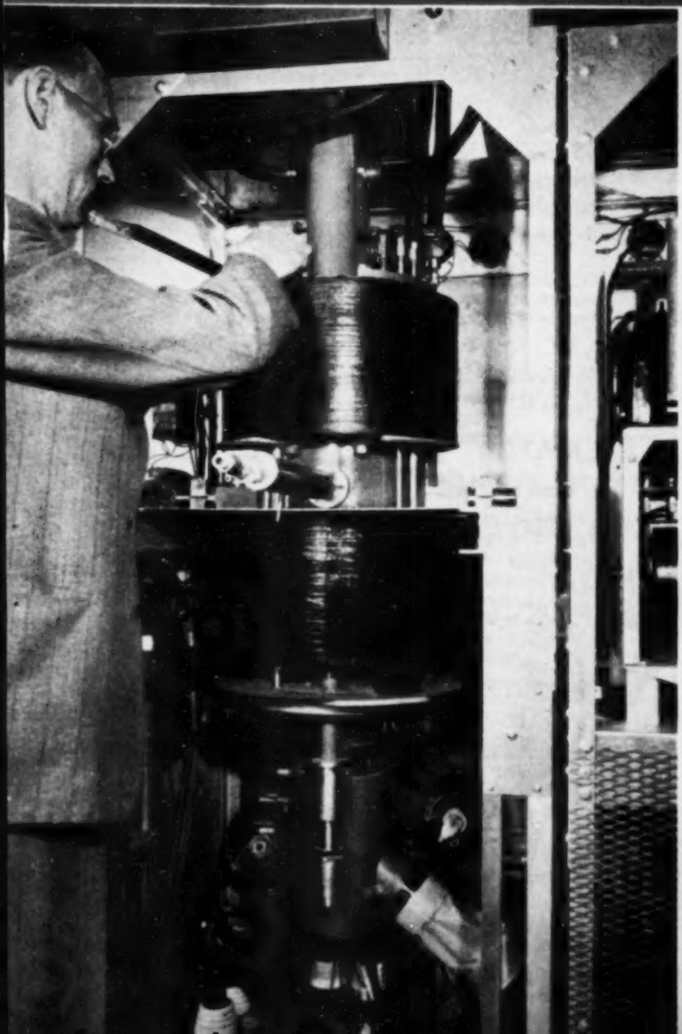

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RADIO-ELECTRONIC ENGINEERING is published each month [illegible] RADIO & TELEVISION NEWS, by the Ziff-Davis Publishing Company, [illegible] Avenue, New York 17, N. Y.

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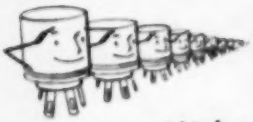
SYLVANIA SOCKETS...



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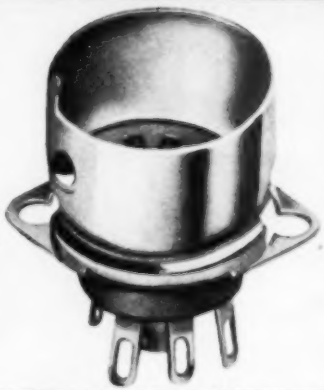

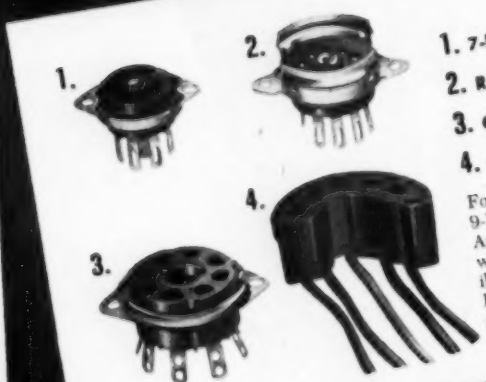

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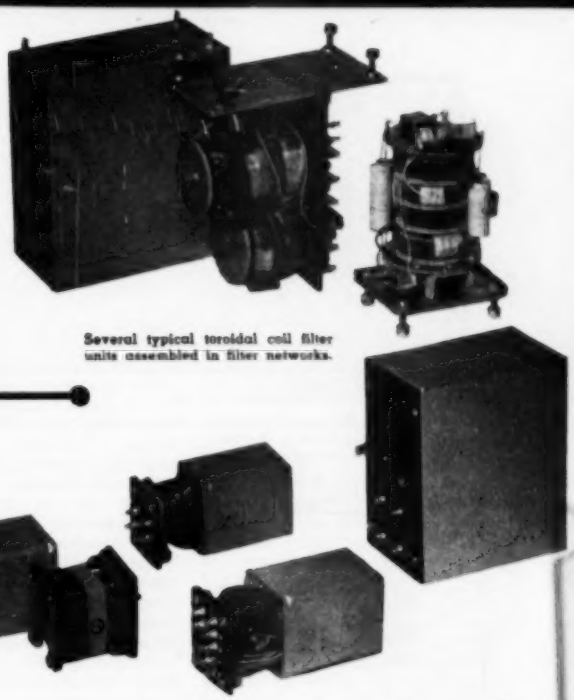
TOROIDAL COIL DEVELOPMENTS



Several typical toroidal coil filter units assembled in filter networks.

By SAMUEL FREEDMAN

Toroidal coils are superior to conventional coils in many respects, but are more difficult to wind.

USE OF THE toroidal or "doughnut" type of coil is becoming increasingly popular in equipment where performance is of primary importance. Wherever employed, it yields high *Q*, energy conservation and concentration, and makes for better utilization of the frequency spectrum through channelization.

Introduced by the *Bell Telephone Laboratories* and the *Western Electric Company* principally to facilitate the handling of communication channels over wire circuits, its application has expanded into the postwar radio development programs of the United States.

Information on toroidal coils has been limited to date, particularly in radio technical literature. Unit cost and the limited production capacity of available toroidal coil winding machines have largely confined the use of toroidal coils in the past. As there is a great difference between winding a straight coil form and winding an endless circular doughnut, each toroidal winder in use today has required high ingenuity and patentable features.

Toroidal coils have been utilized in the audio range of response for some years. More recently, however, they have been developed for i.f. and r.f. coils involving miniaturization and relatively few turns of wire.

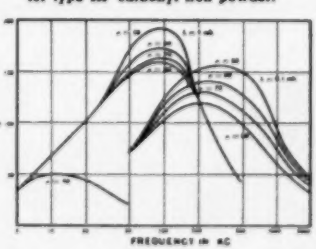
When coils are wound as toroids or doughnuts, they represent the most efficient method of winding. The space factor is the highest in all known methods of winding while the copper resistance becomes the least for the greatest inductance. A toroid requires no shielding since it possesses an extremely small external leakage field, being more favorable in this regard than any other shape known.

The principal manufacturers of toroidal coils are licensed under *Western Electric* patents, this firm having developed the original toroid coil to fill a need for sharper filters in its own channelized long distance telephone equipment.

Toroidal coils achieve improved performances in the following typical applications:

1. Filters in facsimile radio, teletype, telegraph, telephone and sonar systems, telemetering, and control equipment.
2. Saturable responding devices in magnetic amplifiers in lieu of moving parts.
3. Subminiature guided missile filters.
4. Tone filters.
5. Special applications of extremely sharp wide-band filters employing crystals and toroidal coils.
6. High inter-channel attenuation to eliminate distortion and interference in radio reception.
7. Use where magnetic shielding is not provided adequately or at all, and where components must be placed close together. By virtue of its shape, a toroidal coil is less sensitive to pickup from stray magnetic fields; therefore minimum interference or interaction is encountered.

Fig. 1. Graph showing Q vs. frequency at various permeabilities for type HP carbonyl iron powder.



The Toroidal Core

To obtain highest efficiency in any type of audio frequency coil using a core material other than air, the core must be of low-loss material having high permeability. It is also essential that there be no inductance variation with changes in electrical parameters, such as applied voltage and frequency, or with physical conditions, such as temperature or vibration.

The less costly cores are usually composed of ferromagnetic powder, such as carbonyl, in an insulating binder. The individually powdered iron grains are insulated from each other by a binding material. Alternatives are ring-shaped laminations or spirally-wound tape.

At somewhat higher cost, permalloy

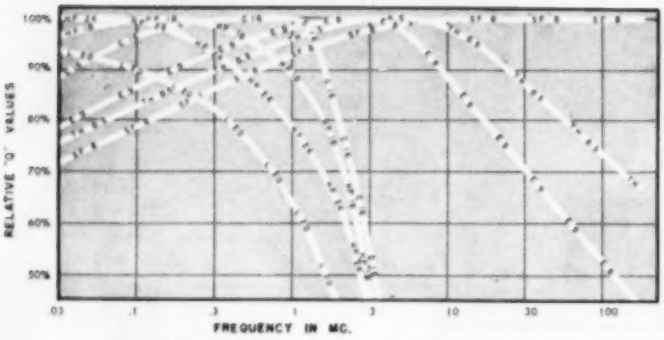


Fig. 2. Relative Q values for various carbonyl iron powders.

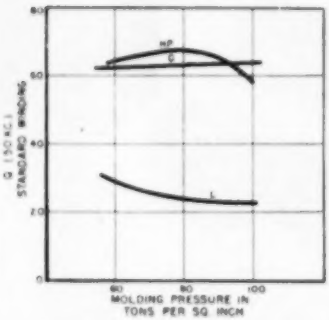


Fig. 3. Graph showing Q vs. molding pressures for carbonyl powders.

dust cores have become popular for high efficiency. One leading manufacturer uses a core material containing 2% molybdenum, 81% nickel, and 17% iron. This material, after being melted and cast, is pulverized into microscopically fine particles. It is then mixed with an appropriate amount of inert binding material, effectively coating each magnetic particle. This entire mass, compressed in hydraulic machines at 100 tons per square inch, forms a solid cohesive toroidal form. After proper annealing at temperatures of 2000° F, the core is checked for permeability and losses.

Carbonyl powders are molded powders of high permeability and low losses at frequencies up to a few megacycles. Cores composed of such powders have a permeability of 40 to 70. The permeability increases with the packing factor (ratio of volume of iron to total core volume). Carbonyl iron powders were discovered in 1890 by the British chemist, Ludwig Mond, who reacted metals with carbon monoxide. Suitable iron materials are reacted with carbon monoxide to form liquid iron. This liquid is then heated to a temperature at which it decomposes iron into powdered form, liberating the carbon monoxide. The carbonyl iron powders formed by this process are pure and the particles are spherical.

Carbonyl iron powders, manufactured by *General Aniline and Film Corporation*, comprise six principal grades: L, HP, C, E, TH, and SF. Their fineness ranges from 30% retention in a 325-mesh screen for grade L, to .5 to 2.0 for grades HP and C, diminishing to only a trace for grades E, TH and SF.

Fig. 9 is a graph showing permeability versus molding pressure in tons per square inch for grades L, HP and C. Fig. 3 shows Q versus molding pressure for the same core materials at a frequency of 50 kc. Fig. 1 illustrates the various permeabilities in terms of Q versus frequency where the inductance is 1 mh. and .1 mh. The molding pressure is held constant at 90 tons per square inch with the permeabilities changed by particle insulation. All these curves are based on HP type powder. Fig. 2 shows relative Q values versus frequencies between .03 and 100 mc. The relative Q values in Fig. 2 are based on the highest of the five grades representing 100%. For example, at 30 mc., SF, TH and E type carbonyl iron powders will exhibit Q values in a ratio of 100 to 87 to 71. The numerals on the curves are permeabilities for form factor equal to 7.5.

The Wedding Ring Toroid

The "wedding ring" toroid was developed to reduce weight and bulk by the use of better core material and improved winders which could work with finer wire and operate with smaller inside diameters for the "doughnuts." Although having about a tenth of the weight of the bulkier toroids, "wedding ring" toroids are still nearly equal in performance. Their miniature size and high capabilities have done much to popularize toroidal coils. The use of the permalloy type core was very helpful in this development; the short magnetic path and relatively large cross section of this core have made it especially low in leakage field.

Fig. 6 shows sketch and performance graphs in terms of Q versus frequency for 1500 and 650 mh. wedding ring toroidal coils, where the inner diameter of the toroid is only ¼" and the outer diameter is 15/16". The weight of such coil is only half an ounce. Fig. 10 shows similar data for 12.0 henry and 5.0 henry coils where the inside diameter of the doughnut is still only ¼", while the outer diameter is 1¼" because of the increased amount of wire winding. This coil weighs 1.6 ounces. Figs. 6 and 10 are based on coils manufactured by *Communication Accessories Company* of Hickman Hills, Missouri.

Fig. 4. Various toroidal coils wound on a Boesch machine.

TOROIDS WOUND ON 6-6S SHUTTLES-NO.40-20 WIRE
MIN.FINISHED HOLE SIZE .500-.750 MAX.FINISHED OD .5"
TOROIDS WOUND ON 4-4S SHUTTLES-NO.42-24 WIRE
MIN.FINISHED HOLE SIZE .375-.500 MAX.FINISHED OD .25"
TOROIDS WOUND ON 3-3S SHUTTLES-NO.42-26 WIRE
MIN.FINISHED HOLE SIZE .200-.300 MAX.FINISHED OD 1.5"

Fig. 8 is a composite, four-section set of graphs showing various types of toroidal filters developed by *Burnell and Company* of Yonkers, New York. The first section of curves gives db versus frequency, as used in subminiature guided missile filters. The six indicated channels are contained in a total volume of 18 cubic inches. The second group of curves gives db versus frequency in cycles per second for tone channel filters available in either 170- or 340-cycle spacing between channels. These are most common among manufacturers of carrier telegraph equipment. The third group of curves shows db versus frequency in kilocycles per second for crystal element channel filters. Such extremely sharp wide-band filters employ crystals and toroidal coils. They are so compact that they have been substituted in very modern equipment for ordinary i.f. transformers. The fourth group of curves shows db versus percentage of phase shift for telemetering filter use. Good linearity of phase shift and good transient suppression, as well as high inter-channel attenuation, have been achieved, thereby eliminating distortion in telemetering reception.

Fig. 7 shows the curve for two filters of a complete set of voice frequency telegraph filters, having 150-cycle spacing and 100-cycle bandwidth, which are manufactured by the same firm. A minimum reduction of 30 db exists where two channels overlap.

Toroidal Coil Winders

In order to appreciate the difficulty and novelty of winding a solid circular core, one might try winding a few hundred turns on a stale doughnut. It is a tiring and time-consuming process. In researching this article, the writer visited the factories of the three manufacturers whose winders are described below.

The pertinent details of interest and variation in anaylzing a toroidal coil winder might include the following:

1. The time it takes to set up a coil winder. Only one coil at a time can be handled, although attempts have been made to develop multiple coil winders.
2. The winding speed, which is limited by the amount of tension and the gauge of the wire used. There are models which operate with slight wire slack and negligible tension.
3. Neatness of the wire lay, depending upon whether the winder has automatic wire laying provisions or whether the toroid must be turned manually as wire deposits on the core.
4. The smallest size wire which can be handled without breakage.
5. The smallest inside diameter of the toroid which can be handled.
6. Whether the machine can wind 180°, 360° or some other amount between zero and 360° of lay.
7. Whether the counter measures length of wire or the number of turns, or both.

The greatest factors of cost in producing toroidal coils are setup time and high investment per machine. Each machine can handle only one coil at a time and it is a manual operation to remove one coil and insert the core of another ready to be wound. The alternative to the use of a machine as described is to laboriously "thread" a coil. The latter is only feasible, if at all, in producing a prototype unit or for making very small r.f. coils having only a few turns of wire.

Every toroidal coil winder utilizes a bobbin which can be opened up either by a removable section or by a split in the bobbin ring. This is necessary in order to put it through the center hole of the torodial core, and to remove the coil upon completion of the winding operation.

Fig. 5 illustrates the *Boesch* toroidal winder, licensed under *Western Electric* patents. Manufactured by the *Boesch Manufacturing Company* of Danbury, Connecticut, it is a combination of eleven assemblies and component parts. A flat base casting provides the means for mounting the various assemblies and components, and an electric motor drives a Graham transmission which, in turn, drives a reversing clutch arrangement. Between the latter two units is placed a directional driving clutch which comes into use when the motor is reversed to reel the wire onto the shuttle. This motor is of the double extended shaft type, with one extension driving the work head of the machine through the conventional pulley and belt arrangement.

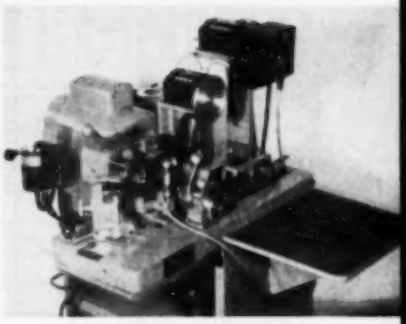


Fig. 5. Boesch toroidal coil winder, manufactured under Western Electric patents.

A "load and fire" device operated from the reversing clutch mechanism controls the reversing action of the machine. This reversing action is the oscillation of the core holder head and its column, movement of which is controlled by adjustment within the range of 45° to 180°. The connection between the load and fire device and the core holder oscillating column is made by means of a rack and pinion. Changing the speed of the Graham drive varies the speed of the coreholder oscillation, permitting close or wide spacing of wire being wound on the core. A solenoid braking mechanism is used in conjunction with the electric motor drive to avoid overrunning. Direction of rotation of the motor is controlled by a conveniently located head lever, and a foot

Toroidal coil winding operation at the plant of Lenkurt Electric Co., Inc.

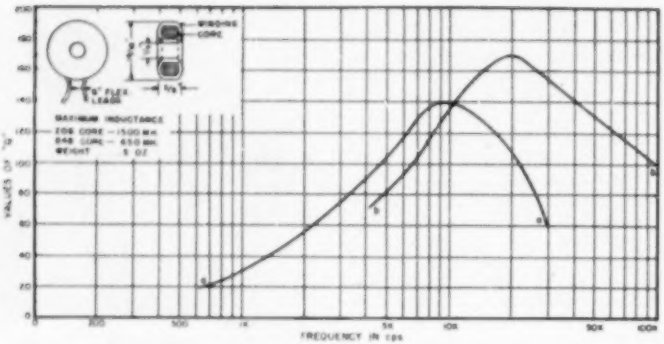


Fig. 6. Q vs. frequency for toroidal coil. Curve a—208 core; curve b—848 core.

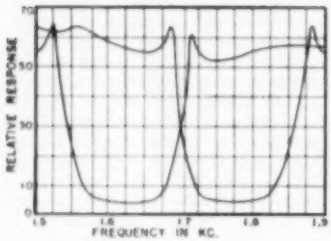


Fig. 7. Curve for two filters of a complete set of voice frequency telegraph filters having 150-cycle spacing and 100-cycle bandwidth.

switch is mounted on the floor for starting and stopping the machine during its normal winding cycle.

The two levers at the right-hand side, mounted on the base of the machine, are the control connections between the load and fire device and the oscillating core clamping head. These levers, when properly positioned, completely disconnect the core clamp head, leaving it free to be moved to any position within the angular range of its movement, which is determined by the particular setting of the load and fire device. The control is such that the point of reversal will always be in time, regardless of the position of the core clamp head at the time the load and fire mechanism is engaged. The hand lever shown directly above the shuttle provides the necessary operational means for loading and unloading the core. The wire tensioning device is shown to the immediate right of the shuttle.

Provision is made for changing the shuttle speed when winding wire of various gauges. No. 42 to No. 20 gauge enameled copper wire is successfully wound at approximately 1150 turns per minute for the finest wire, and for several of the next larger sizes. Other types of wire, such as "Litz" and cotton-covered wire, are wound with equal facility.

The machine is equipped with two separate counting devices, both of which are mounted on the base casting, are readily accessible, and are in full view of the operator. The linear counter is a pre-set assembly which provides the footage counting of wire from the spool to the shuttle. The machine is also equipped with a core loop counter for counting the turns of wire being placed on the core. This pre-set electromechanical device is so arranged that the machine automatically stops when the desired number of turns have been made.

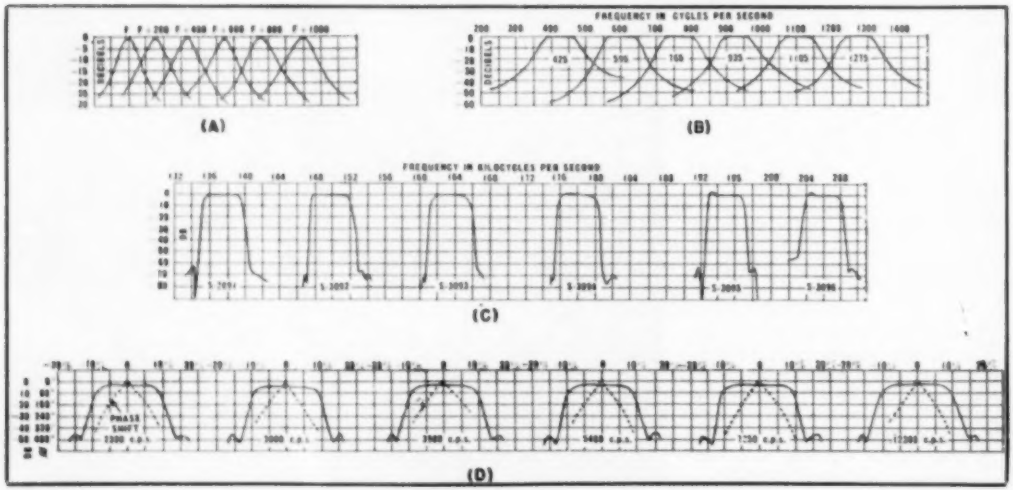
The core clamp is of the double movable jaw type, centralizing the core regardless of its thickness. Extended core clamps are provided for the winding of some of the larger size cores.

A scale and pointer, shown in the illustration immediately ahead of the core clamp, comprise the visual means for angular positioning of the unit when the load and fire mechanism is being adjusted for degree of stroke or oscillation. This scale arrangement permits adjustments within an accuracy of ±1°.

Three sizes of work heads are provided. The smallest is designated as No. 3 (or 3") shuttle capacity; the medium size as No. 4 (or 4") capacity; and the largest size as No. 6 (or 6") capacity. All are completely interchangeable by removal of the screws and are doweled into position, eliminating any adjustments for the setup of the work head

(*Continued on page* 31)

Fig. 8. Toroidal filter graphs. (A) Subminiature guided missile filters; (B) Tone channel filters; (C) Crystal element channel filters; and (D) Telemetering filters.



PRINTED CIRCUIT PRINTERS

Flat and cylindrical surfaces may be printed with these semi-automatic circuit printers.

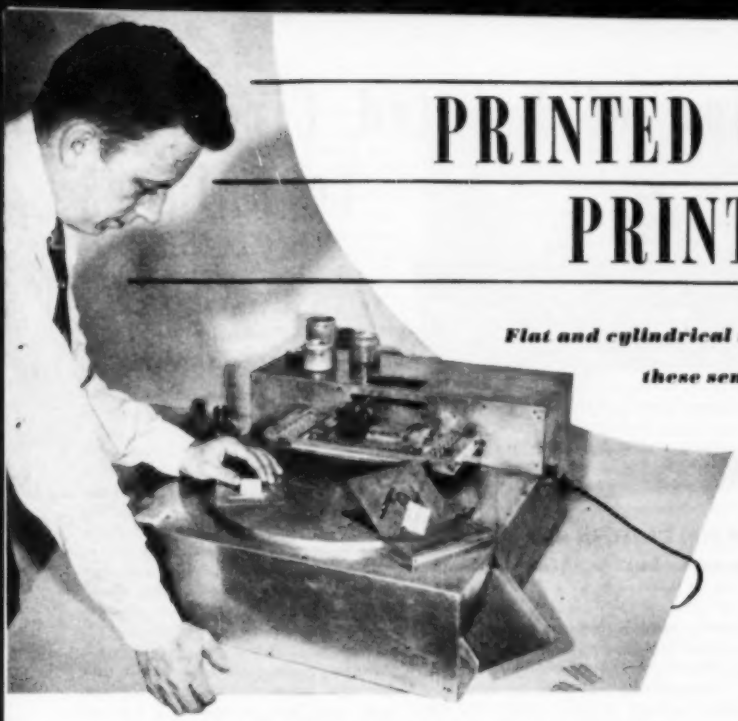


Fig. 1. Ceramic plate is placed in loading position on NBS automatic printer.

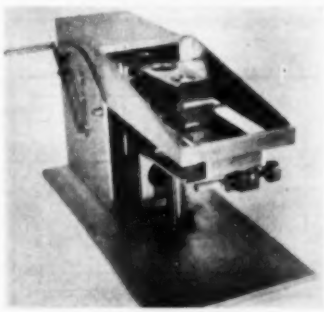
TWO SEMI-AUTOMATIC machines for printing electronic circuits, one for flat surfaces and the other for cylindrical surfaces, have recently been developed by Robert L. Henry and associates of the National Bureau of Standards. The new NBS printers are products of a continuing program of printed circuit development sponsored by the Navy Bureau of Aeronautics. Although few if any automatic printers have hitherto been developed for printed circuit applications, such printers seem to offer two important advantages. First, they are faster than hand printers and more economical for use in quantity production. Second, and perhaps equally important, they give a more uniform product.

Printed circuits—in which wiring and components are superimposed directly on insulating bases—are being used increasingly because they can be economically produced in quantity and because they facilitate miniaturization of equipment. Circuits are usually printed manually by a stenciled-screen process in which a rubber squeegee forces silver paint onto the insulating base through openings in a fine silk or metal screen. Firing of the printed plates then drives off the paint vehicle and leaves an adherent silver film of high conductivity.

The NBS printer for flat plates is motor-driven and more fully automatic than the printer for cylindrical surfaces. In the flat plate printer, a turntable accepts the unprinted plate at a loading position, carries it to a printing position, and after printing carries it to an unloading position, where it is automatically flipped into a chute.

In regular operation, three plates are processed simultaneously: while the first plate is unloaded, the second is printed, and the third is loaded. The turntable stops while these operations are performed, then advances the plates one-third of a revolution, stops again, and so forth. The usual production rate, about 1000 plates per hour, can be increased to 1500 per hour without loss of printing quality but at the expense of excessive wear and tear on the machine.

Fig. 2. Semi-automatic printer for cylindrical surfaces developed by NBS.



As the turntable advances the plates from position to position, they rest on rectangular platens about 3 by 4 inches in size. These flat platens are normally flush with the turntable. However, when a plate-carrying platen reaches the printing position, the platen rises and presses the plate against the underside of the printing screen, which occupies a fixed horizontal position. While the plate is held against the screen, a rubber squeegee is automatically moved over the top surface of the printing screen, forcing conducting paint through the screen onto the plate in the desired pattern. The platen is then lowered to its flush-with-the-turntable position and is advanced by the turntable another third of a revolution to the unloading position. Here the platen is tilted, and the printed plate slides into the discharge chute.

The flat-surface printer is at present loaded by hand, one plate at a time, as the turntable moves the three platens past the loading position. Otherwise the process, including the flipping of the printed plates into the discharge chute, is entirely automatic. The loading of the unprinted plates, and also the carrying away of the printed plates, could be done automatically by conveyors.

The NBS cylindrical-surface printer was developed for the printing of cylindrical ceramic forms less than 0.5 inch in diameter. Such small ceramic cylinders are usually out-of-round and present a much more difficult printing problem than larger, more perfect forms.

The cylindrical-surface printer is loaded manually by slipping the cylinder to be printed over a mandrel. A single stroke of a hand-operated control lever then puts the machine through the entire printing cycle and operates a release mechanism which drops off the printed cylinder.

(*Continued on page* 27)

Application of Printed Circuit Techniques

By
R. BAHR, JR.
and
W. H. HANNAHS
Physics Laboratories
Sylvania Electric Products Inc.

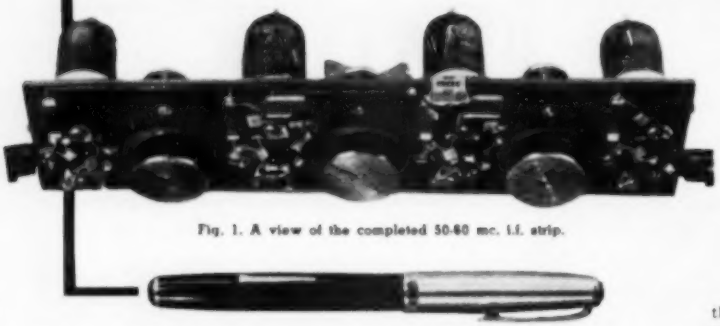


Fig. 1. A view of the completed 50-60 mc. i.f. strip.

Design of stagger tuned 50-60 mc. i.f. strip using selective etching to form coils and chassis shield.

AIRBORNE ELECTRONIC systems have many problems in common with their land and sea counterparts as regards performance, reliability, maintenance, and spatial requirements. However, in almost every case, airborne equipment is required to operate under greater extremes of temperature, acceleration, vibration and voltage variations. In addition, it must be as light as possible and use minimum space in an already crowded vehicle. The equipment must be readily removable for servicing, replaceable, and its packaging suitable for installation in many different locations for the best utilization of available space. With the increased dependence of both military and commercial aviation on electronic equipment in navigation and communications, the search for improved methods of construction has led to many new techniques and the development of smaller and smaller components. This article describes the work done in the application of etched circuits to common radar circuits in order to illustrate the advantages which may be obtained from their application to airborne electronic equipment problems.

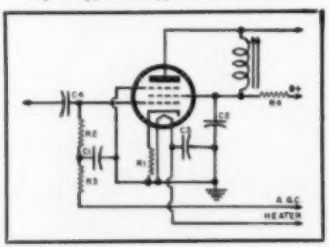
Etched circuit techniques give promise of solving some of these problems by further reducing size and weight as well as cost of manufacturing the equipment.

A broad-band stagger tuned i.f. amplifier operating in the 50 to 60 mc. region was designed and constructed to illustrate the techniques involved in the application of etched circuits. Before discussing this particular amplifier, however, a brief review of the history of broad-band i.f. amplifiers and their application to radio and radar systems will be useful for a better understanding of the problems involved in applying etched circuits to these systems.

The use of broad-band i.f. amplifiers was required in conjunction with the superheterodyne circuit in the early development of FM and television transmissions. This broadbanding was usually accomplished in two ways—first by increasing the i.f. frequency to permit greater bandwidth for the same Q factor and, secondly, by reducing the Q of the tuned circuits by means of loading resistors. The development of radar during World War II employed these techniques as it progressed from the low-frequency, low-definition systems to the microwave, high-definition systems requiring higher i.f. frequencies and wider bandwidths to pass the spectra of the narrow pulses transmitted.

The early i.f. strips were "synchronous tuned," that is, all tuned circuits were aligned to a single midband frequency and bandwidth obtained by loading each circuit equally so that the cascaded response would be as required. Later designs used "stagger tuned" systems yielding greater gain-bandwidth factors than those obtained with the synchronous tuned systems. At the present time the latter systems are being used successfully for most broadband i.f. amplifiers.

Fig. 2. Typical stagger tuned i.f. stage.



For radar systems of the past war, an i.f. frequency of 30 mc. was standardized as a suitable compromise between gain-bandwidth products obtainable with tubes such as the 6AC7. However, further developments in tube design of the miniature and sub-miniature types have permitted an increase in the optimum i.f. frequency to the 50 to 60 mc. range and additional research has indicated the practicability of standardizing at a frequency as high as 100 mc.

Suitable bandwidth for radar systems varies from 2 to 5 mc. depending on the tactical function, *i.e.*, short range high-definition systems or long range limited-definition systems. Local oscillator stability is also a determining factor in the required bandwidth since normal local oscillator variations should not be detectable as amplitude variations of the received signal.

Gains of much above 120 db are difficult to obtain due to regeneration problems and small variations in production models.

From this discussion it may be concluded that, from a performance point of view, an i.f. amplifier suitable for a radar system should operate at a midband frequency of 50 to 60 mc., have from 2 to 5 mc. bandwidth and have a gain of about 120 db.

A schematic of a typical stage of a stagger tuned amplifier is shown in Fig. 2. With the exception of a few small resistors and bypass capacitors of comparatively small dimensions, it can be seen that the major items left are the tube, socket, and tuning inductances. The major limitations therefore lie with the tube and its socket. Tubes have been decreased in size from the standard octal based tube to miniature and subminiature types. The amplifier to be described uses miniature tubes to illus-

trate the etched circuit techniques but sub-miniature types would serve equally well and provide a further reduction in size and weight.

The material used for the production of these etched circuits is a copper-clad phenolic laminate having a one-to-three mil foil banded to each side. It is commercially available in several varieties and grades of laminate, bonding material and thickness of copper foil. Although the types available at present undoubtedly are lacking in many respects in ability to withstand the rigors of airborne service, it is felt that this problem can be solved by the manufacturers of the material once the specific requirements are known. It is hoped that this example of the production and development techniques required and the type of results obtained by use of etched circuitry in electronic equipment will be useful in the further application of etched circuits to mass-produced electronic equipment.

The copper-clad laminate was used as a sub-assembly chassis with coils and wiring as well as the chassis shield produced with selective etching. Low-ohmage printed resistors were sprayed through a mask to form the decoupling impedances for the plate and a.g.c. circuits. For the tube sockets, the phenolic laminate is punched in such a manner that the holes function as the lower portion of a standard wafer-type socket. Fig. 3 shows the negative from which the etching was made. The foil directly behind the coils on the top side is also etched away to prevent decreasing the inductance and Q.

Spiral coils etched in this manner were on the order of 1 microhenry and had measured Q's of from 100 to 150, depending on the line thickness and outside diameter of the coils. Test coils were readily reproduced from the same photographic negative with small deviations in inductance and Q. Tuning is accomplished with a screw having an oversized head. A tuning range of ± 6 mc. was obtained with the use of a head diameter slightly smaller than that of the coil. The brass tuning slugs decreased the Q from about 100 to 90 and this decrease was essentially uniform over the tuning range. Tuning discs made of powdered iron were also used but were not as satisfactory, being mechanically weaker than the brass discs.

Calculations for simple staggered systems show that maximum Q factors of 60 to 70 are required for the 4-megacycle bandwidths. Thus it would appear that the etched coils produced on the XXXP phenolic laminate are quite adequate for this application. For other applications, the Q of these coils could be improved, if required, by the use of heavier gauge foil, silver plating and a lower loss backing material.

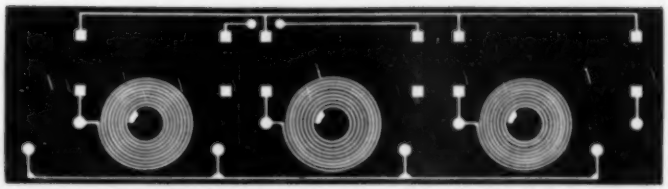


Fig. 3. Negative from which the etching was made for the chassis.

The decoupling resistors were formed with sprayed graphite-silver powder compositions which were then stabilized by baking at temperatures just below the decomposition point of the plastic base. The tolerances on these particular components are quite broad, since any value from 100 to 300 ohms will provide enough decoupling. With further development of the process techniques, sprayed resistors could be used as coil damping and cathode compensating resistors, the tolerances of which are more critical. Small resistors of the "Globar" variety were used for these applications although standard ½-watt sizes could also be used.

Bypassing and coupling condensers are of the ceramic type and their small physical size permits short leads and isolation from other components. The use of miniature components at these frequencies reduces considerably the possibilities of feedback and stray coupling. As in most i.f. amplifiers, the output circuit required shielding and was constructed of a standard double-tuned transformer within a shield can which is not shown in the photograph. A 1N34 detector and associated filter were also contained in this shield can. A view of the completed amplifier is shown in Fig. 1.

For laboratory construction of printed breadboard models, a "direct inking" method was used which permitted experimental layouts to be made using drafting instruments and an ink which resists the action of the etching solution. Since physical layout for high-frequency circuits must be planned rather carefully to reduce feedback, trial arrangements must be made and a development method such as the direct inking described is convenient in arriving at a satisfactory layout. After the physical layout has been determined, an accurate layout drawing may be made to several times scale with India ink on a background suitable for photographing. Spirals are difficult to draw without special compasses, but a close approximation can be made with four centers and 90° arcs. After the layout drawing has been photographed, the negative is reduced to scale and the etched design produced from this negative by contact printing to the surface of the copper foil which has been photosensitized, usually with cold top enamel. As in photoengraving, the convenient echant is ferric chloride and speed of etching may be regulated by strength, temperature, and agitation of the solution.

These techniques have been applied to the development of the i.f. strip with performance comparable to a standard wired model. The basic circuit is designed around the miniature type 6CB6 which was developed especially for 41.25 mc. television service. It is similar to the more familiar 6AG5, having a higher g_m and smaller interelectrode capacities. The suppressor grid is brought out separately, permitting the use of cathode compensating. Circuit design is shown in Fig. 4. The first stage is connected as a grounded grid circuit to provide a low-impedance input for a signal generator and also to simulate

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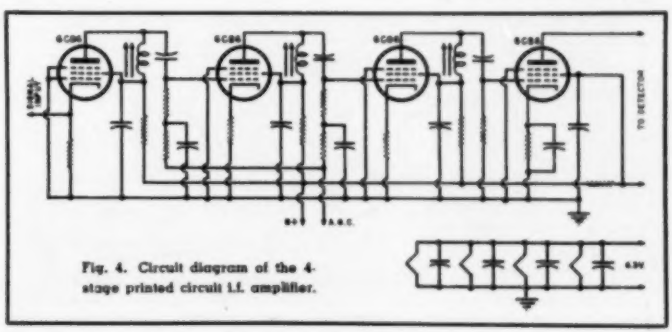
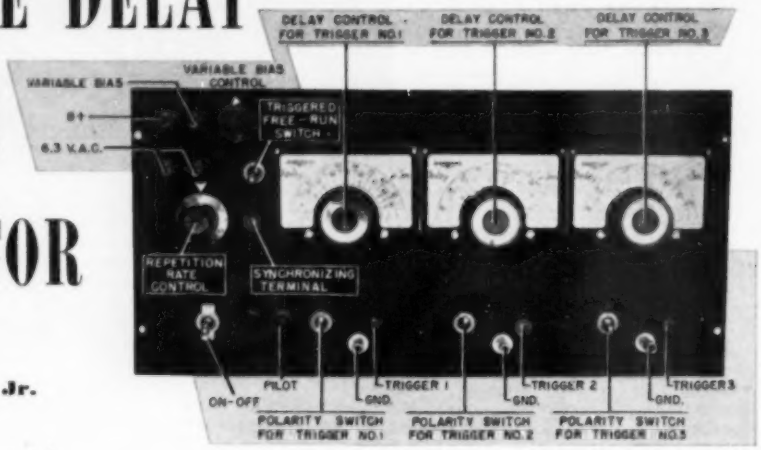


Fig. 4. Circuit diagram of the 4-stage printed circuit i.f. amplifier.

VARIABLE DELAY TRIGGER GENERATOR

by
H. H. PATTERSON, Jr.

Fig. 1. Front view of the completed unit with the functions of the various controls indicated.



Three independent triggers, variable in time, are provided by a master blocking oscillator, delay multivibrators, and triggered blocking oscillators.

ONE OF THE more essential pieces of laboratory equipment for use in pulse circuitry is the variable delay trigger generator. When fairly high writing speed oscillography is being used, it is essential to have a means of adjusting the start of the trace or circuit function so that the most economical use of the scope trace is obtained. The problem of starting the sweep early enough to see the leading edge of any triggered circuit action is solved by a device of this type.

Reference to the block diagram, Fig. 5, will make the operation of this simple, yet indispensable, piece of equipment clear. As illustrated, a master blocking oscillator drives three independent delay multivibrators and these, in turn, trigger three driven blocking oscillators. Thus, three triggers that may be varied in time are obtained. In a typical test setup, trigger No. 1 is used to initiate the oscillograph sweep, while the other two triggers are available to initiate the operation of other circuits whose operation may be timed before, or after, the start of the scope sweep by the proper use of the delay controls. All the triggers are of equal amplitude, around 125 volts peak, and may be reversed in polarity by a toggle switch on each output. For the *Westinghouse* Type 134 BWF pulse transformer and the circuit constants shown, the output pulses are about 0.4 microseconds in width at the half-voltage point.

The master blocking oscillator is arranged to be either free-running or driven, as the occasion demands. In the free-running state with the circuit parameters shown, rates from 200 to 5000 cycles may be obtained. When free-running is used, a pulse appears at the trigger input terminal that may be used to synchronize a similar delay generator which is operated in the driven state. The direct-coupled multivibrator shown has the advantage of a short recovery time compared to the ordinary *R-C* coupled multivibrator, thus allowing high repetition rates.

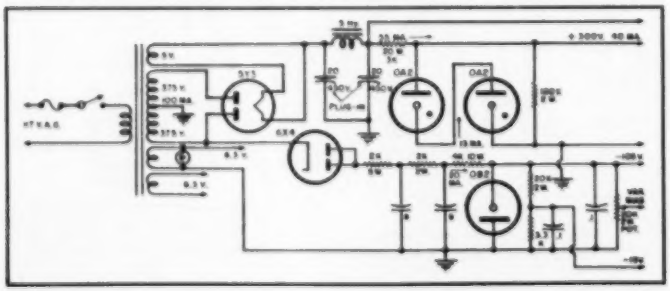
A timing diagram is shown in Fig. 3. The only design difficulty likely to be encountered in a circuit of this kind is the possibility of one multivibrator locking with another when operating at the same, or almost the same, delays. Such trouble is especially hard to clear up when the initiating triggers are taken from the same source, as they are here. This difficulty was encountered in this unit but was effectively eliminated by obtaining the triggers from the 200-ohm resistors in the two cathodes of the master blocking oscillator.

Since the multivibrators radiate considerable hash when in operation, careful isolation by correct placement of parts and decoupling is necessary, as well as the elimination of direct capacitance coupling through the trigger source.

Only when no detectable change in delay is observed as one trigger is moved back and forth over the same delay interval set on the observed trigger can the unit be considered completely successful. In the generator described here, this "crosstalk" has been reduced to less than 0.03 microseconds by decoupling and the use of vertical shields above the chassis between the multivibrator variable condensers. Shields are not necessary below the chassis as the chassis itself is a wave guide beyond cut-off for the frequencies involved.

It may be argued that the delay

Fig. 2. Circuit diagram and parts list for the power supply used with the unit.



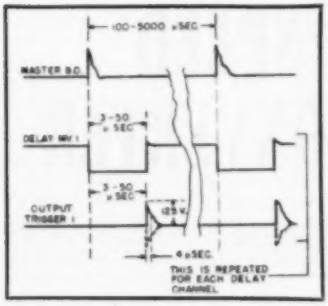


Fig. 3. Timing diagram showing the operation of one channel. A delay of three to fifty microseconds can be obtained independently in each channel, without danger of interaction with other channels. Pulse width is 0.4 μsec at half-voltage.

intended for the oscillograph could well be fixed and the variable feature of the remaining two trigger sources would still allow the obtaining of positive or negative time. The Model G synchronizer, designed at the M. I. T. Radiation Laboratory during the war, while featuring only one variable delay, was arranged in such a manner. This is not to deprecate the Model G which contained other useful circuits such as a fast sweep attachment of the 208 oscillograph. Modern scopes, however, have fast sweeps built into them.

To see the advantage of a variable scope delay, consider a case where two circuits are being operated with some precise, predetermined delay between them, and assume that a faster sweep is to be set on the oscillograph. When the faster sweep is obtained, it will necessitate a change in the delay between the initiation of the scope sweep and the observed circuits to allow the observed phenomenon to be brought to the center of the screen. With a fixed scope delay, each of the two variable delays must be moved to obtain this result, thus losing the precise delay set between them. With a variable scope delay, the initiation of the scope sweep is moved in less time than it takes to say the words and nothing is lost in the timing of the observed circuits.

With additional delay circuits, such as may be obtained by synchronizing two similar variable delay generators, the time saved when changing sweep speeds is greatly increased by the variable scope delay.

Using the constants shown, the multivibrators supply delays up to 50 microseconds. An increase in the variable condenser or the associated grid resistor in the multivibrators will increase this to any desired maximum compatible with the repetition rate in use.

The built-in power supply is not run at full capacity and terminals are

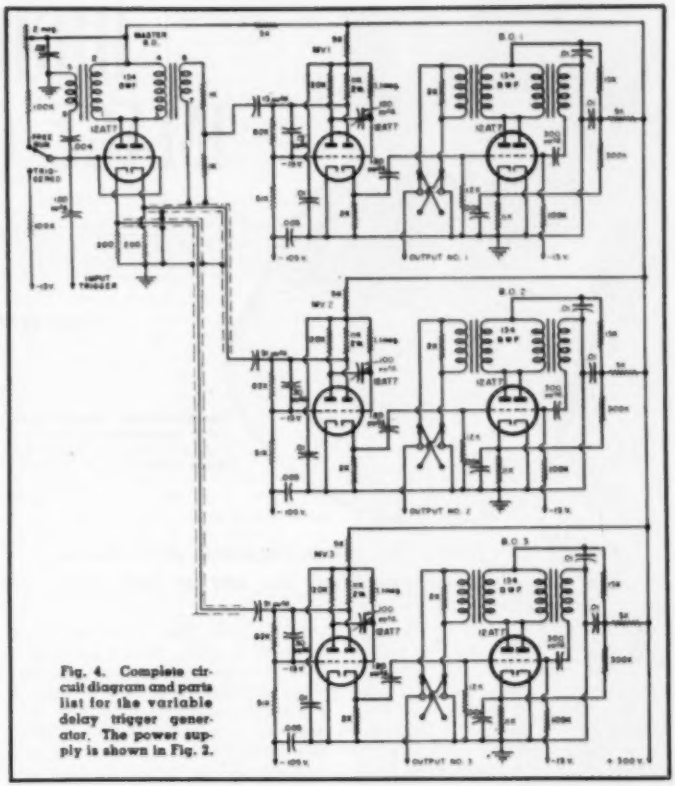


Fig. 4. Complete circuit diagram and parts list for the variable delay trigger generator. The power supply is shown in Fig. 2.

brought out to be used as a convenient bench source when only a few mils are needed. The negative supply is also brought out for bias supply purposes. It is equipped with a potentiometer to facilitate its use.

Credit for construction of the models shown in the photographs should be given to Mr. F. B. Cunningham and Mr. L. D. Moritz.

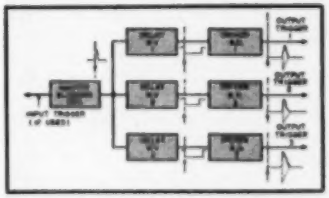
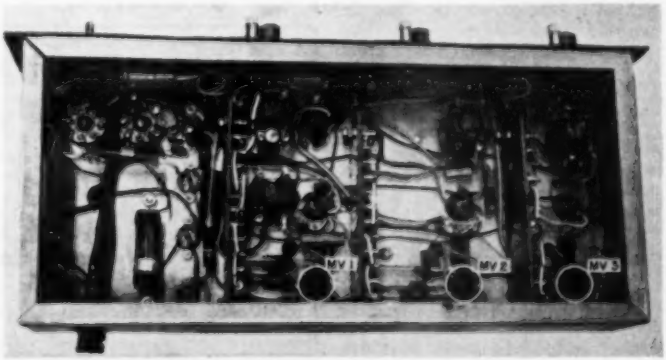


Fig. 5. Block diagram of unit.

Fig. 6. Under-chassis view, showing the three multivibrator compartments.



HIGH SPEED IMAGE CONVERTER

This photograph shows the exterior appearance of the Mullard grid-controlled high-speed image converter tube, ME 1201.

By HERBERT WEIL

Very high-speed and short-duration phenomena can be photographed with the aid of this tube.

A NEW ELECTRON TUBE, called an *image converter*, has been developed in the Research Laboratory of *Mullard Ltd.*, the well-known British radio and electrical components manufacturer. This image converter (trade designation ME 1201) is capable of photographing phenomena occurring in the region of one-hundred-millionth of a second (1/100,000,000 sec.). It is four million times as fast as an ordinary box camera. It is so fast in action that it has actually been used to photograph the progress of the millionth-of-a-second discharge of the world's fastest electronic flash tube which was developed during the war to study projectiles in flight. British experts believe that this amazing new electronic device may revolutionize ultrahigh-speed photography.

Many of the limitations imposed on high speed photographic techniques, it has been found, can be overcome by using an image converter as an optical shutter. In this method an optical image is transformed into an electron beam which can be deflected or shut off by conventional means. Basically, this device consists of an evacuated glass cylinder with flat ends, a semi-transparent photo-cathode being deposited internally at one end and a luminescent screen at the other. When an image of an object is focused onto the photocathode, the electrons emitted are accelerated by a positive voltage applied to the screen; the phosphor is then excited to form a visible image.

The working principle of the image converter was first put forward by G. Holst in 1934; developments after 1934 were mainly to improve the definition attainable on the fluorescent screens of the simple Holst tube. Improvements in definition were effected as a result of the inclusion of electromagnetic and electrostatic focusing systems. By 1939 several tubes of this type had been constructed, and the military applications of the infrared converter gave impetus to the development and production of new tubes to meet the demands of the armed forces. From the work carried out with existing image converters, it was concluded that the following features were desirable in the design of the tubes for high speed photography:

1. The cathode should have a good sensitivity in the region of 4000A.

2. The luminescent screen should have a backing layer to (a) protect the phosphor from caesium vapor during processing, and (b) make the tube opaque to light coming through the photocathode.

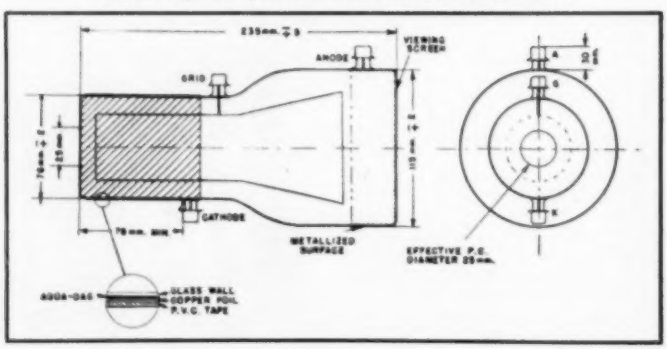
3. A grid with a good control characteristic should be incorporated in the tube in order to avoid the pulsing of very high anode voltages.

4. An electromagnetic or a combination of electromagnetic and electrostatic focusing systems should be incorporated in order to insure high definition pictures.

The *Mullard* grid-controlled image converter has been specially designed for high speed photographic applications. The photocathode and screen of this tube are optically flat plates. An internal glass rod supports and insulates the grid electrode, which consists of a layer of aluminum on the glass. Contacts to the photocathode, grid and luminescent screen are brought out for standard tube caps. The luminescent screen is aluminum-backed.

The photocathode of this tube is of the caesium/antimony type. It has a high sensitivity in the blue region of the light spectrum and is, on this account, most suitable for high speed

Line drawing showing the basic construction of the converter tube.



photographic work. A green luminescent Willemite screen is normally used, giving a picture approximately 4½ inches in diameter. The diameter of the photocathode is a little over 1¼ inches so that the tube can conveniently be used at an image magnification of four times.

During the development of this tube it was found necessary to devise a special technique to make caesium/antimony cathodes with a very low resistance on the order of a few hundred ohms per square unit as compared with megohms in the case of normal semi-transparent caesium/antimony photocathodes used in photomultipliers, supericonoscopes, etc., these new photocathodes having an average sensitivity of 20 μamp/lumen to tungsten light at 2700°K. There are two main types of screen available for the *Mullard* ME 1201: Willemite, giving a green trace with a light emission peak at 5200 Angstrom units and a persistence of several milliseconds; and a nickel-killed zinc sulphide giving a peak output at 4300 Angstrom units and a fast decay on the order of 5 microseconds. Both types of screen can resolve 50 lines per mm., and the light in each case can be efficiently recorded on high speed orthochromatic or panchromatic emulsions.

The *Mullard* image converter normally requires an anode voltage of 6 kv. and a grid voltage of 3 kv., thus making it possible—for static operations—to use any conventional power pack having a high output impedance. A number of ways may be suggested in which the ME 1201 can be used for dynamic operation. For example:

1. Single shot exposures pulsing the cathode negative
2. Single shot exposures pulsing the grid and cathode sequentially
3. Scanning
4. Stroboscopic operation
5. Multiple shots

In method 1, a line is charged to 5 kv. and is then shorted by a hydrogen thyratron through a resistance equivalent to the line impedance, whereupon a negative pulse of approximately 2.5 kv. appears at the cathode. In spite of a number of difficulties, this system has been found to work reasonably well and records can be obtained for exposures in the region of 1/10 microsecond (10^{-7} sec.).

The technique of method 2 was developed by Dr. R. F. Saxe, of the Armament Research Establishment at Fort Halstead, England. This has several advantages over the first method, the principle of operation of the apparatus being as follows: the tube is 'opened' by dropping the cathode voltage to 60 v. and is closed again by grounding the grid, hydrogen thyratrons being used as switches. When using the image converter for viewing non-luminous objects, it is normally sychronized to the peak light output of a *Mullard* LSD2 microsecond flash tube. No difficulty is experienced in synchronizing to the peak of the flash tube discharge with an exposure of 1/20 microsecond (5×10^{-8} sec.).

In scanning, the possibility exists that, by the use of suitable external deflector coils, the electron beam in the image converter can be moved across the luminescent screen. Thus, records similar to those obtained with drum cameras can be secured. For scanning requirements, a special tube was recently designed by *Mullard Ltd.* in cooperation with Dr. J. S. Courtney-Pratt, of Cambridge University. This tube, the ME 1200, is similar to the ME 1201 but has no grid electrode. Using this tube for photographing the birth and growth of an explosive reaction, writing speeds of 60,000 meters per second have recently been achieved, giving a resolution of 1600 lines across the field of 3½ inches in diameter, or approximately 460 lines per inch.

The visual examination of stroboscopic effects (method 4) is another field in which the image converter has possibilities. For instance, a recent demonstration given by the Physical Society in London showed the movement of stress waves in a transparent medium. In this demonstration the 'shutter' or grid of the image converter was working at 20 kc., giving one-microsecond exposures. By the use of high speed drums to transport the film, it is possible that a series of 1/10 microsecond (10^{-7} sec.) exposures could be recorded at the rate of 200,000 frames per second or faster, as against a maximum of 100,000 frames per second obtainable with the Marley camera in previous demonstrations.

Method 5—a further development of the scanning technique which has also been demonstrated by Dr. Courtney-Pratt—makes it possible to take a limited number of pictures in quick succession. In these experiments the event under observation was focused onto the center of the photocathode of the image converter in such a way that the image was confined to one-third the useful cathode diameter. Two deflecting coils at right angles were used giving field strengths of H, O and −H. By means of a mechanical commutator these fields were applied in suitable phase to deflect the whole picture successively to any of nine discrete positions. A frame interval on the order of

(*Continued on page* 25)

Progress in the explosion of a firework as photographed from the screen of the Mullard image converter tube.

POINT-CONTACT and JUNCTION TRANSISTORS

A junction transistor (below) compared in size with a type 6AK5 tube (above).

By
JOHN A. DOREMUS
Motorola, Inc.

Transistors are superior to vacuum tubes in many respects, but also have certain limitations which must be considered in designing new equipment.

THOSE WHO work in the communication phase of this industry sometimes have the feeling that "there's nothing wrong with electronics that the elimination of a few vacuum tubes would not fix!" This is a sordid thought to have concerning the element around which the industry revolves. Yet many basic short-comings can be traced back to the vacuum tube.

A vacuum tube has a limited and unpredictable life. A piece of communication equipment is often called on to operate continuously for years, and it is desirable that this equipment be completely unattended; yet tube failures require constant and costly maintenance.

The fact that a vacuum tube consumes power inefficiently is well known in the television industry. Very large power transformers are required for many television sets, a good share of the size being required to provide heater power for 15 to 20 tubes. Mechanically, too, a tube is bulky and fragile.

Now, for the first time, there is an alternative device which can be considered a legitimate contender to the throne that has been occupied by the vacuum tube for over 35 years. It can do many of the jobs now done by vacuum tubes and do them more efficiently and more dependably. This device is called a *transistor*.

What is a Transistor?

Transistor is the name given to a crystal-type amplifying element made of a semi-conductor such as silicon or germanium. It is interesting to note that the name was derived from the fact that this device had been called a "transit resistor" by early workers in the field who were really searching for new ways of making nonlinear resistors. At present, a transistor is equivalent to a triode. Its physical embodiment can be extremely small, since its ability to amplify does not depend upon its size. It is very rugged.

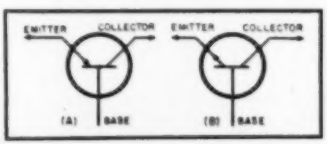
The ability of a transistor to amplify depends upon the unusual property of semi-conductors to support two kinds of conduction simultaneously: one, the travel through the material of excess electrons, and two, the travel through the material of "holes," which are really the lack of electrons and therefore constitute an equal positive charge. In a semi-conductor, electrons travel much more slowly than they do in a conductor and "holes" travel even more slowly than the electrons.

Transistors are constructed in two distinctly different types. One is called the point-contact type; the other is called the junction type. Their construction results in different performance characteristics which will become apparent as this story unfolds.

What Can It Do?

In most circuits, the transistor will do the same job as a vacuum tube while consuming 1/1000 as much power. Take, for example, a radio or television set. In all stages up to the second detector the signal level is less than a milliwatt and in most of them less than a microwatt. Yet an average of a watt or more heater power and a watt of plate and screen power are burned up in order to obtain the desired amplification.

Fig. 1. Schematic representation of (A) the point-contact transistor and (B) the junction transistor.



Transistors can give 20 to 50 db of gain, depending upon the type, while consuming less than two milliwatts of power. The junction type of transistor is about ten times more efficient than the point-contact type for small-signal amplification.

As the transistor has no filament or heater, there are no problems of filament burn-out. Transistor life has been predicted in several ways, all of these predictions pointing toward a figure of 70,000 to 90,000 hours, or approximately ten years. Since a transistor does not stop working suddenly, there being nothing to burn out, the life figure above has been based on the time at which its gain will drop 3 db. For most applications, this is not necessarily the end of its useful life.

Table 1 gives a tabulation of the properties of both the point-contact and junction types compared with vacuum tubes. As will be seen from this tabulation, transistors can do a better job than tubes within the limits of power and temperature up to 30 mc.

Photo Transistors

The boundary in a junction type transistor is extremely photosensitive and therefore can be made into an attractive photocell. The first photocells of this type were simply diodes.

One important characteristic of a transistor photocell is its spectral sensitivity which is most strong in the red and infrared regions. A second important characteristic is its efficiency. A PN junction unit (diode) has a sensitivity of 30 ma./lumen, and 10 to 15

milliwatts of a.c. can be obtained from a simple circuit using this type of unit. An NPN photo transistor can give a light conversion efficiency about 30 times greater than this, or about 1 ma./millilumen.

Why the Excitement?

Transistors are causing a great deal of excitement at this time because:

1. Production of practical quantities of the point-contact units has begun.
2. Large advances in circuit design have been made in the past year.
3. The bringing of the junction transistor out of the laboratory and the readying of it for production opens even newer and broader fields of application.
4. Stability of design has been established.
5. Dependability of units has been assured by uniform production.
6. Designability has been established. Units can now be designed to a certain set of parameters.
7. There is a need to alert the industry to the impact of this element so that circuit design work can now be done to take advantage of transistors.
8. Manufacturers believe that most rapid progress can be made under pressure of circuit designs to stabilize types.
9. Five manufacturers are already "in the business." These are *Western Electric, General Electric, Raytheon, Sylvania* and *RCA*.

How Does It Work?

The operation of the transistor can best be understood by reviewing some of the characteristics of semi-conductors. Certain elements in the fourth column of the Periodic Table exhibit properties whereby they seem like insulators under certain conditions, while under other conditions they seem like conductors. These elements have been called semi-conductors.

In the molecular structure of a material like diamond, all valence bonds are satisfied, so the material behaves like an insulator. If the crystal is heated, the thermal excitation can cause a valence electron to be knocked out of its usual place, leaving this electron (negative charge) free to move about in the crystal. The place from which the electron came is called a "hole," and this area exhibits a local positive charge. Under this condition, the diamond behaves somewhat like a conductor. Eventually, the electron and the hole may recombine. At all times, however, the entire crystal is electrically neutral.

Certain other elements in the fourth column of the Periodic Table, like silicon and germanium, require less energy to knock electrons out of the valence bond positions; in fact, at normal temperatures, electrons and holes are being liberated and recombined continuously. These are called intrinsic semi-conductors.

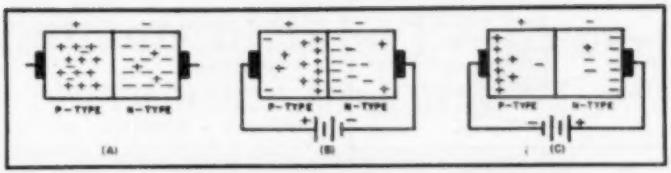


Fig. 2. Schematic representation of a junction between P-type and N-type germanium, showing action of electrons and "holes" with various battery polarities.

If an electric field is applied to an intrinsic semi-conductor, the electrons move toward the positive terminal and the holes move toward the negative terminal. Holes can be treated exactly like electrons except that their charge is of opposite sign.

It was learned early that the presence of certain impurities in a semi-conductor greatly changed its conductivity. These impurities were identified and the following two effects catalogued.

If an impurity from the fifth column of the Periodic Table is present, atoms of this impurity replace atoms of the semi-conductor in the crystal structure. Since fifth column elements have five valence electrons, the extra electrons are free to migrate throughout the crystal. This is called an N-type (negative) semi-conductor and the impurity atoms are now called donors or donators.

If an impurity from the third column of the Periodic Table is present, the impurity atoms similarly replace atoms of the original material in the crystal. Third column elements have only three valence electrons and, consequently, one valence bond is left unsatisfied. The holes thus formed are also free to move about in the crystal, and the material is now called a P-type semi-conductor. These impurity atoms are generally referred to as acceptors.

It is interesting to note that only a few donor or acceptor atoms are required to produce substantial changes in the resistivity of a semi-conductor.

Two other properties of semi-conductors are important:

1. Holes can be introduced into an N-type semi-conductor, and electrons can be liberated in a P-type semi-conductor by passing current into it.
2. Electrons travel much more slowly in a semi-conductor than they do in a conductor, and holes travel even more slowly than electrons.

Now, examine the operation of a PN junction rectifier (Fig. 2). This may be made up of a single crystal of germanium, for example, the two parts of which contain different impurities. One part is N-type and the other part is P-type. If a potential is applied to the two ends of this rectifier so that the positive terminal is connected to the P material and the negative terminal to the N material, the electrons and holes move toward each other and recombine. The voltage source keeps this going. The apparent resistance is very low, and a high current flows.

If we reverse the polarity of the applied potential, the effect is much different. The holes and electrons are pulled away from the junction and away from each other, and the unit tends to become an insulator. Very little cur-

Table 1. A tabulation of the various characteristics of the point-contact and junction transistors compared with the characteristics of conventional vacuum tubes.

	Point-Contact Type	*Junction Type*	*Tubes*
Gain	20 — 30 db	30 — 50 db	20 — 50 db
Efficiency (Class A)	30%	45 — 49%	.1 to 25%
(Class C)	90%	95%	70%
Life	70,000 hrs.	90,000 hrs.	5000 hrs.
Vibration	100 g	100 g	
Shock	20,000 g	20,000 g	
Uniformity	± 3 db	± 2 db	± 3 db
Minimum powers	1 mw.	1 microwatt	1/10 watt
Temperature	70°C	70°C	500°C
Frequency	30 — 70 mc.	3 — 5 mc.	60,000 mc.
Gain × bandwidth	1000 mc.	120 mc.	1000 mc.
Noise figure	45 db	15 db	10 — 30 db
Power	100 mw.	1 watt	1 megawatt

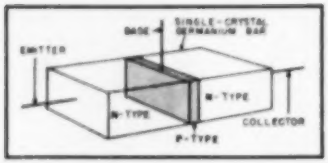


Fig. 3. Basic construction and nomenclature for junction transistors.

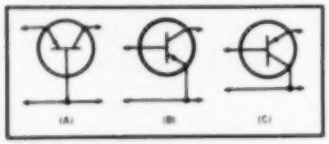


Fig. 4. Three possible methods of connecting the junction transistor: (A) Grounded base; (B) Grounded emitter; (C) Grounded collector.

rent flows. Therefore, this type of junction is a very good rectifier.

Next, pass on to the junction type transistor (Fig. 3). Here, there are two junctions made very close together—usually from a single crystal of the semi-conductor.

The left-hand junction is biased in its forward direction, forming a very low resistance path for the flow of current. To insure an efficient emitter, the N-type material is more strongly N than the P-type is P. An excess of electrons is generated, and these travel into the center region.

The right-hand junction is biased in its non-conducting direction. The electric field across this junction makes it attractive for the excess electrons liberated at the emitter junction to continue on across the collector junction to the collector terminal.

Variations in the emitter current will cause variations in the number of free electrons available and thus cause variations in the collector current. The Greek symbol alpha (α) has been established as the transfer current gain of the transistor. α may be defined as the change of collector current for a specific change in emitter current at a constant collector potential.

$$\alpha = \left(\frac{\Delta I_c}{\Delta I_e}\right)_{V_c}$$

The factor α is dependent upon the efficiency of the emitter, the transport ratio and the efficiency of the collector.

$$\alpha = \gamma \times \beta \times A$$

γ = emitter efficiency
β = transport ratio
A = collector efficiency

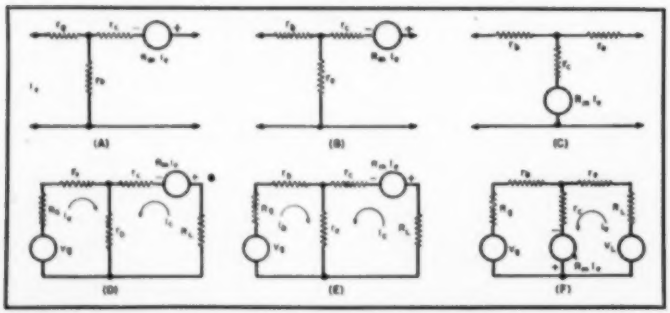
If the emitter current were all electrons and none recombined with holes in the center, P-region, and all of them reached the collector, then α could attain a maximum value of unity. In practice, α values of .95 to .98 can be achieved.

As mentioned previously, the emitter (or input) junction has a very low impedance, but the collector (or output) junction has a very high impedance. The variation of a current through the high impedance collector circuit by an almost equal current variation in the low impedance emitter circuit constitutes an appreciable power gain. Junction transistors have been made with up to 50 db of power gain.

Now, consider the point-contact type of transistor. This is basically a block of semi-conductor material, such as germanium or silicon, where two pointed probes are placed very close together on top of the block. During manufacture, the contact areas are "formed" by passing current pulses through them. This creates small areas of P-type material directly under the points, and the resulting transistor is essentially a PNP unit.

Operation is similar to that described for the NPN transistor except that all supply potentials are of opposite polarity and the important conduction is principally by holes instead of electrons. However, because of the geometry of this unit and the relative mobilities of holes and electrons, α values as high as 3 to 4 can be obtained in commercial units.

Fig. 5. Equivalent circuits for the various junction transistor connections: (A) & (D) Grounded base; (B) & (E) Grounded emitter; (C) & (F) Grounded collector.



A transistor, therefore, possesses two mechanisms whereby power gain can be obtained when it is used as an amplifier. One of these is due to the fact that the output impedance is considerably higher than the input impedance; the other is due to α, the current gain possible in point-contact types and the newer hook-collector types of units.

Transistor Characteristics

The transistor is definitely a three-terminal device. Unlike the vácuum tube, the fact that the transfer characteristics are bilateral cannot be forgotten, even for equivalent circuits. Changes in output conditions affect the input characteristic as changes in input conditions affect the output characteristic.

The transistor is definitely a voltage amplifier. By varying an input voltage, a much larger variation in an output voltage is obtained. Too, transistors like best to see constant current power supplies whereas tubes work best with constant supply potentials.

As mentioned previously, the emitter circuit of a transistor is a diode biased in its forward or conducting direction. The bias supply for this element must be of a constant current nature to prevent self-destruction.

The alternating current equivalent circuit of a transistor for most applications is represented as a three-terminal network with two series resistances, r_e and r_c, and one shunt resistor, r_b, as shown in Fig. 5. These parameters are resistive at normal audio frequencies. The truest representation of the transfer generator would be a current supply having the value αI_e shunted across r_c. Since it is inconvenient to work with current generators, this may be replaced with an equivalent voltage source in series with r_c having the value $R_m I_e$.

The input impedance of a transistor is equivalent to the sum of r_e and r_b and has practical values from 200 to 600 ohms. The output impedance is equivalent to r_c plus r_b. This may be from 20,000 ohms to over a megohm.

Like a vacuum tube, a transistor has an upper frequency limit caused by the capacities between the elements. Because of the close spacing, these capacities are somewhat greater than in vacuum tubes. Capacity effect on the emitter is not serious because of its inherently low impedance, but the capacity effect upon the collector is somewhat more important, especially in junction types. The principal frequency limitation in a transistor, however, is due to another cause, namely, the slow transit speed of the electrons and holes in the semi-conductor material. These two effects define an upper frequency limit for junction type units at 3 to 5 mc., while point-contact units have been used up to 70 mc.

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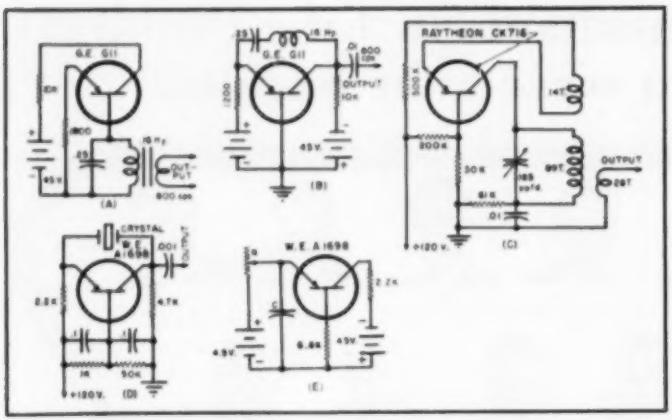


Fig. 6. Several practical point-contact transistor circuits: (A) and (B) are oscillators having an output of 800 cps. (C) is a broadcast superhet oscillator. (D) is a crystal-controlled oscillator. (E) is a multivibrator in which C is adjusted for the desired frequency and R is adjusted for proper operation.

Temperature provides another serious limitation to the environment of a transistor. At elevated temperatures, the noise generated within the unit becomes important in magnitude, and the thermal agitation causes a large change in the collector impedance, thereby affecting the amplification.

Much has been said about noise in transistors, which is evidence that research has only begun on the fundamental causes of this noise. This noise, like other random noise, decreases as frequency increases. A point-contact type unit shows a noise factor of 40 to 50 db while junction type units have a much better noise figure, 10 to 15 db, which compares favorably with tubes.

Practical Circuits

Like the vacuum tube, the transistor lends itself readily to all types of circuits including amplifiers, oscillators and switching circuits. In many cases, the transistor shows improved flexibility since there is no common filament supply to consider. Low input impedance minimizes shielding problems.

The commonly used grounded base connection is equivalent to a grounded grid vacuum tube circuit. In this connection, the principal problem is stability. Base resistance is common to both input and output circuits. Since there is no phase reversal in the transistor element, the common base resistance constitutes a regenerative feed-back path—most important in units with an α greater than unity.

The value of r_b has been controlled in all units currently being manufactured to provide inherent stability when no external resistance is added to the base circuit.

In the grounded base connection, between matched impedances, up to 20 to 30 db gain per stage is easily achieved. Because the impedance transformation through a transistor amplifier is a step-up, it is always necessary to use an interstage stepdown transformer to realize full power gain.

At a large sacrifice in gain, it is possible to cascade grounded base transistor stages directly. In this sort of an amplifier, 6 to 8 db gain per stage is possible.

Another popular circuit is the grounded emitter circuit, equivalent to a conventional grounded cathode tube circuit. Input and output impedances are both on the same order of magnitude —from 4000 to 10,000 ohms. Output impedance is negative if α is greater than one and must be stabilized with external resistance in the collector circuit.

This circuit has a transfer phase shift of 180°. Practical amplifiers can be built with 20 to 30 db gain per stage. Cascaded stages without interstage transformers show an improvement over the grounded base connection.

The transistor may also be used in a grounded collector circuit. This circuit, which has a high input impedance and a low output impedance, is equivalent to a cathode follower tube amplifier.

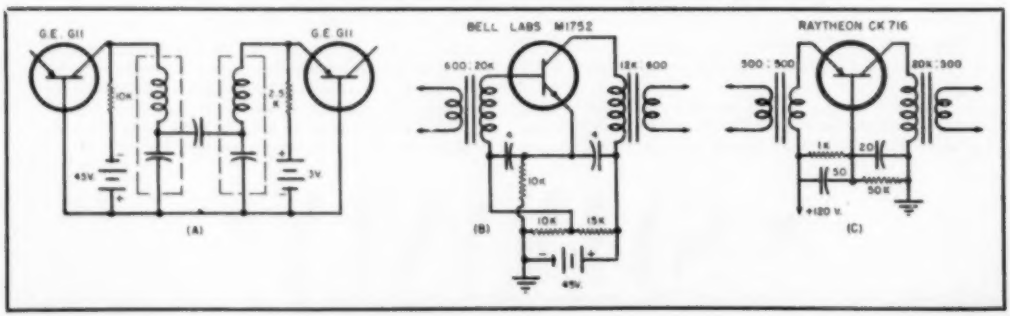
Both input and output impedances may be negative in this connection, but the circuit can be stabilized with external resistors. It is interesting to note that this circuit has a phase reversal going through it in one direction while it has no phase shift going through it in the opposite direction. It is possible to make an amplifier of this type with 15 db of gain in both directions.

To produce low noise input, higher power output and more gain per stage without interstage transformers, combinations of grounded base followed by grounded collector stages and grounded emitter followed by grounded collector stages may be used.

For oscillators, several circuits have shown good performance. A parallel resonant circuit in the base is a very popular circuit. Coupled series-resonant circuits in the emitter and collector leads produce a TE-TC oscillator.

A few conventional circuits that have

Fig. 7. (A) A practical 455 kc. i.f. amplifier. Note that the two i.f. coils are in separate cans. (B) An audio amplifier using a junction transistor. Output level, 10 dbm; gain, 30 db; battery power, 0.2 watts. (C) Audio amplifier using point-contact transistor having a gain of 20 db and an output level of 50 mw.



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been used in practice are shown in Figs. 6 and 7.

Another important application of transistors is in switching circuits. With a vacuum tube, plate impedance can be controlled from several megohms to a few thousand ohms, while a gas tube can provide a switch from several megohms to a few hundred ohms. The transistor, on the other hand, can provide a switch which is capable of several megohms in its non-conducting condition to a fraction of an ohm in its conducting condition. This is the most effective electronic switch known to date. It can be made to operate in a fraction of a microsecond and be stable in either the open or closed condition much like a flip-flop circuit.

This application makes the transistor extremely useful in computers, telephone switching circuits and many industrial control operations. Experimental circuits have been built using transistors to replace the vibrator in an automobile radio power supply.

The transistor provides miniaturization of the major element of electronic circuits, thus shifting the impetus for improvement back to the transformer manufacturers and, more particularly, to the condenser manufacturers. Transistor circuits require the use of high-capacity, low-voltage coupling capacitors which at present are neither small, inexpensive, nor dependable.

The transistor also throws out an interesting challenge to the battery manufacturers to produce a constant current source rather than a constant potential source. At the present time, 80% of the power used in transistor circuits is wasted in the dropping resistors required to provide the constant current supplies from a constant voltage source.

Amplifier and oscillator circuits are limited at the present time to about 70 mc. This is a problem which is being worked on by all those engaged in transistor research.

The elimination of heat in the equipment employing transistors is a problem which does not have a very attractive solution. Obviously, it is not desirable to locate a transistor next to a red-hot 6L6. On the other hand, in equipment using all transistors and no tubes, the heat dissipated will be extremely small and will solve some of the currently existing aspects of the problem.

Summary

In conclusion, it can be said that the transistor is an adequate substitute for the vacuum tube with attractive improvements in power required, efficiency and dependability. At the present time, its application is confined to the limits of 70°C, 70 mc. and about 70 milliwatts.

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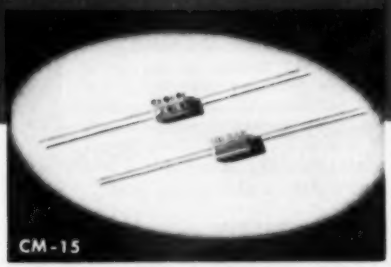
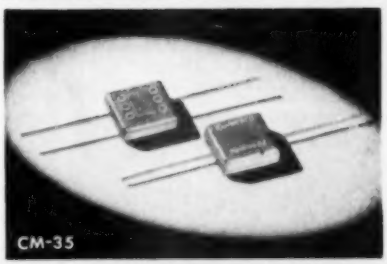
Table 2. Data sheet showing characteristics of several point-contact and junction transistors.

Manufacturer's number	CK 716	G11	A1698	M1689	M1725	M1729	M1752[2]	TA161B
Transistor type	Contact	Contact	Contact	Contact	Contact	Contact	Junction	Contact
Manufacturer	*Raytheon*	*GE*	*WE*	*BTL*	*BTL*	*BTL*	*BTL*	*RCA*
Type of service			Switching	Switching	Audio & Carrier	Audio & Carrier		
Diameter	.255	.16	.239	*.125	.239	.239	3/8x5/32	
Height (over-all)	.775	0.55	.750		.750	.750	7/32	
Mounting	*Cinch* 8749	5 pin sub-miniature	*Cinch* 8672	solder	*Cinch* 8672	*Cinch* 8672	solder	
Grounded Base								
Collector current, ma.	4	2	15	40	20	20	5	
Collector voltage (neg.)	40	40	100	50	50	50	50	
Collector dissipation (mw.)	100	25	120	80	200[1]	200[1]	50[3]	140
Emitter current (ma.)	10	1	15	40	15	15	5	
Cutoff frequency (mc.)		5	5		5	5		
Input (emitter) resistance, r_e	250	50		800	195	190	25	300
Output (collector) res., r_c	15K	20K		10K	8K	15K	13M	15K
Feedback (base) resistance, r_b	75		200	500	115	75	240	120
Forward resistance, r_m	25K			15K	16K	32K	13M	
Current amplification factor α	2.5				2.1	2.5	.98	2
Grounded Emitter								
Emitter current (ma.)	0.5				1.5	1/2[3]		
Collector voltage	10				5	30		20
Collector current (ma.)	1.5				4	5/7		3
Average power gain[4]	18	*19			18	20/18		22
Average power output (mw.)	3				4.5	/50		
Noise figure (db) at 1000 cps.					48	54		
Input termination					500	300		
Output termination					1000	15K/15K		

* Approximate.
[1] at 50 degrees C ambient.
[2] Specifications, not data.
[3] Lower right values are strong signal conditions. Upper left values are weak signal conditions.
[4] Grounded base connection.





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With the introduction of the Model AH-1, *Ohmart* now offers a line of gammometers with ranges as low as .1 microcurie to 10,000 microcuries full scale, calibrated in terms of radium (standard), iodine-131, or cobalt-60. Full details and price information are available from *The Ohmart Corp.*, 2347 Ferguson Road, Cincinnati 38, Ohio.

LAMINATION MATERIAL

With the increasing scarcity of certain metals, especially nickel, *Thomas & Skinner's* new OrthoSil, a 4-mil iron-silicon material for laminations, is finding many applications. Designed especially for high frequency inductors, it

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GAS SWITCHING TUBE

According to the *General Electric Company*, a small gas switching tube which resembles a miniature cigarette lighter may play a key role in viewing objects at close range on radar screens. The *G-E* Tube Department at Schenectady, N. Y., has announced the addition of the new A-TR tube, which weighs

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Type 6038 acts as a switch to decouple the transmitter from a common transmitting and receiving antenna, thereby allowing the antenna to receive the return signal after a radar signal has been transmitted. Speed is essential to attain full sensitivity of the system for nearby objects.

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TOROIDAL LOADING CORES

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Available in several values of inductance and in a number of physical arrangements, these coils are wound on high-stability iron powder toroidal cores. (The illustration shows a lead-sleeve type of coil with 7-foot cable stub for making connection.)

The new coils are applicable to circuits using carrier frequencies of 3 to

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Precision-built for reliable service and for quick, accurate measurements of hydrogen-ion concentrations, a new universal pH meter is now available from the Research & Control Instruments Division of *North American Philips Company*, 750 South Fulton Avenue, Mount Vernon, N. Y. This instrument is designed for all pH and rH work, for potentiometric titrations and for oxidation-reduction-potential investigations.

For laboratory research and industrial testing purposes it provides a measuring accuracy of 0.01 pH or 0.5 mv., a range of 0 to 14.15 pH and 0 to 1415 mv., absolutely currentless measuring with no phenomena of polarization, and zero indication by cathode-

ray tube. It can be used with glass, quinhydrone, hydrogen and platina electrodes and is direct calibrated for the first three.

The *Philips* pH meter is enclosed in a wood cabinet, and an auxiliary chemical assembly, similarly enclosed, is available as an accessory.

DOUBLE PULSE GENERATOR

The Model 903 double pulse generator, manufactured by the *Berkeley*

Scientific Corporation, 2200 Wright Avenue, Richmond, Calif., produces either single or double pulses such that

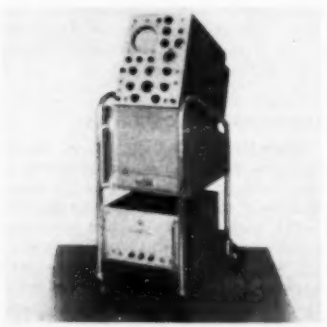
the amplitude or width of each pulse is continuously and individually variable. Spacing between pulses is controlled by means of a calibrated front panel knob. Developed for general laboratory work, the unit is ideally suited for designing and testing amplifier circuits, gating and gating control circuits, high speed scalers and wide-band amplifiers.

Model 903 consists of two pulse forming circuits with an integrating network to provide a time delay between pulses. It is capable of producing either positive or negative pulses. The rise time of the pulses is .035 microseconds and decay time less than .15 microseconds.

CATHODE-RAY OSCILLOSCOPE

Designed primarily for the observation and photographic recording of very fast-rising waveforms having a low duty cycle, the *Tektronix* Type 517 wide-band high-voltage cathode-ray oscilliscope is now in production at *Tektronix, Inc.*, 3627 S. E. Cooper Street, Portland 2, Oregon.

A quantitative instrument, Type 517 has all critical voltages electronically controlled to preserve the accuracy of the sweep and vertical amplitude calibrations. Distributed type vertical am-

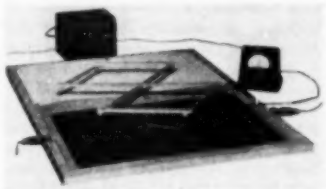


plifiers provide a rise time of .007 microseconds with a maximum sensitivity of .1 v/cm. An accelerating potential of 24 kv. on a metallized cathode-ray tube allows photographic recording of single sweeps at the maximum writing rate permitted by the vertical amplifier and sweep circuits.

ANALOG FIELD PLOTTER

A versatile tool for rapid solution of complex two-dimensional field problems has been announced by the Special Products Division of *General Electric Company*, Schenectady, N. Y.,—a portable analog field plotter which sets up electrical field patterns in a thin conducting-paper surface on the plotting board. Analogy between the electric field in the paper and the related field problems allows an easy solution to a broad range of difficult problems.

Since the new plotter can be used for the study of air flow patterns, as well as electrical fields, fluid flow and tem-

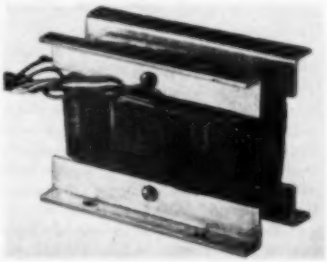


perature distribution, it may have extensive use in the aircraft industry.

The plotter consists basically of a plotting board and exploratory stylus, with d.c. power supply operated from 115 volts a.c., a high-accuracy multiturn voltage divider, and a sensitive microammeter.

SATURABLE TRANSFORMERS

Magnetic Amplifiers, Inc., announces a new standard line of saturable trans-



formers including both open type and hermetically sealed units, manufactured in accordance with military specifications. Power output is phase reversible a.c. with output levels of one watt to one kilowatt, at both 60 and 400 cps. Ambient temperature limits are from −60°C to over +80°C.

For bulletin listing applications and typical circuits with actual component

(*Continued on page* 29)

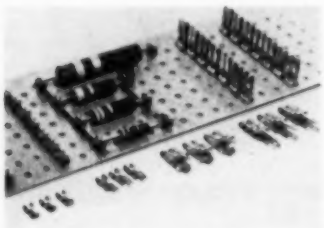
2 PROBLEMS
1. How can I strengthen the magnetic field without increasing the size of my coil?
2. How can I reduce resistance, and hold my coil to the same space?
2 ANSWERS!
1. More winding of same gauge on same size coil base.
2. Larger gauge wire on same size coil base.
when you use
PRECISION BOBBINS
NO INSULATION STRIPS NEEDED
Each winding layer fits snugly into the one below. This permits use of minimum coil size, yet provides adequate windings — enables you to cut costs substantially.
Precision Bobbins are spirally wound and heat-treated for extra strength; tube ends swaged to firmly lock vulcanized flanges. The entire Precision Bobbin is impregnated to meet Underwriters' requirements.
SEND FOR SAMPLES TODAY!
PRECISION PAPER TUBE CO.
2051 W. Charleston St.
Chicago 47, Ill.

NEWS BRIEFS

TERMINAL DESIGN

The new and completely different terminal design announced by *Alden Products Company*, 117 North Main Street, Brockton, Mass., is a possible answer to the problem of putting component mounting and soldering on a production basis.

Alden 650 series terminals have a unique press configuration. Component leads snap in and are held for soldering without the necessity of twisting or wrapping with pliers. Only a minimum



of soldering is necessary, and heat is dissipated quickly, permitting use of short leads.

These new terminals make it possible to secure multiple leads with a minimum of effort and, at the same time, obtain a finished product that is neat, compact and easily accessible for test or removal.

ELECTRONICS PRODUCTION BOARD

Marvin Hobbs, electronics adviser to the chairman of the Munitions Board, has been appointed a member of the Electronics Production Board, succeeding Mr. C. W. Middleton, who is now engaged in field activities for the Department of Defense.

The Electronics Production Board was established within the Defense Production Administration several months ago and is responsible for the over-all coordination of the electronics production program.

APPOINTMENTS AT BELL

Dr. Ralph Bown, director of research for *Bell Telephone Laboratories* since 1946 and a member of the *Bell System* for more than 30 years, has been appointed vice president in charge of research. Dr. Bown has been internationally recognized for his pioneering research and development work in the broad field of communications engineering, much of which has been concerned with various aspects of radio broadcasting and with ship-to-shore and overseas telephony.

Other organization changes at *Bell Laboratories* include the following: Dr. J. B. Fisk is now the director of research—physical sciences; Dr. H. T. Friis has been appointed director of research in high frequency and electronics; Dr. W. H. Doherty is the new director of research in electrical communications; and Dr. R. M. Burns was appointed chemical coordinator in addition to his duties as director of chemical and metallurgical research.

ULTRASONIC VIBRATOR

Ultrasonics are now being used at *Raytheon Manufacturing Company*, Waltham, Mass., to conserve materials vital to the nation's defense program. Tungsten, high on the list of critical materials, is among those materials being salvaged by means of a new device —an ultrasonic vibrator.

This device, vibrating at a frequency of more than three times that of the

highest audible pitch, shakes glass beads off tungsten rods salvaged from vacuum tubes which have proved faulty during manufacture and which require reprocessing. Developed by *Raytheon*, the device permits removal of glass sealed to the tungsten rods ten times faster than was possible by previous methods.

Other glass-sealing alloys can also be salvaged by this method, which can be applied to a variety of tubes including those used in x-ray, Geiger counters, and radio and television equipment.

INSTRUMENT MERCURY

The *Bethlehem Apparatus Co., Inc.*, is now processing and marketing mer-

cury specifically for use in instruments requiring a high degree of accuracy. An unbreakable 5-lb. polyethylene bottle with a flexible dispensing tip delivers the mercury directly to the instruments from a dust-proof chamber in which it has been purified of all contaminants.

It is claimed that this instrument mercury goes beyond the standard chemical tests which are adequate for reagent mercury, and meets much more exacting physical tests, remaining bright indefinitely in storage and in instruments.

Also available in larger containers, it is suitable for use in manometers, polarographs, thermometers, cathode cells, meters and gauges of all types. For further information, write direct to the *Bethlehem Apparatus Company, Inc.*, Hellertown, Pa.

LORAN NAVIGATION TABLES

Since the National Bureau of Standards inaugurated a Navy Department-sponsored project devoted to the preparation of tables for the newly adopted Loran system of navigation some ten years ago, more than 100 tables, involving some 5000 pages, have been prepared to provide Loran coverage for all the principally traveled areas and important military installations in the world.

Recently a program was developed to carry out Loran computations on SEAC (National Bureau of Standards Eastern Automatic Computer), which greatly reduced the number of machine-

hours and the cost of computation required to complete a Loran project.

Loran has proved to be one of the most reliable means for navigating far out at sea or in the air because low frequency radio waves are used to carry the navigational information. Transmission is effective at distances up to 700 nautical miles during the day and 1400 nautical miles at night.

A.I.E.E. FELLOWS

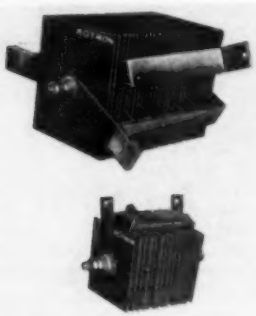
Two *General Electric* authorities in the field of mercury arc power rectification have been named Fellows of the American Institute of Electrical Engineers—Lysle W. Morton and August Schmidt, Jr. Both are employed in *G-E's* Power Electronics Division at Schenectady.

Mr. Morton joined *G-E* as a test engineer upon his graduation from the University of Minnesota in 1924, and was transferred to the General Engineering Laboratory in 1926 where he became instrumental in the development of the mercury arc power rectifier.

Mr. Schmidt, a member of the nation's atom-bomb Manhattan Project in 1943-4, also joined *G-E* as a test engineer following his graduation from Cornell in 1920.

HIGHER VOLTAGE CELLS

In January, 1948, *Kotron Rectifier Corporation*, Newark, N. J., began pro-

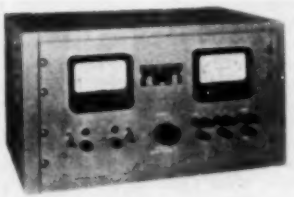


duction of selenium rectifier cells capable of blocking 40 volts r.m.s. while delivering the standard current density of 0.333 ampere per square inch in a single phase bridge circuit with a maximum ambient temperature of 35°C. Three years of experience in actual use having dispelled any doubts as to the value of these high voltage cells, *Kotron* has now announced a new selenium rectifier cell with the capacity to withstand 60 volts r.m.s.

The principal advantage of employing higher voltage cells is the material reduction made possible in the size and weight of the rectifier stacks, thus effecting conservation of critical materials necessary in manufacture. Far fewer cells are required in series to withstand higher applied voltages.

POWER SUPPLIES

The new line of standard electronic power supplies recently developed by



the *Perkin Engineering Company*, 318 Kansas Street, El Segundo, Calif., is finding varied application in many of the national aircraft and electronic laboratories. Varying in rating from 100 to 500 milliamperes and from 200 to 1000 volts, these d.c. power supplies are entirely electronic in nature and have very rapid recovery times.

There are eight models, some of which have bias voltage ratings of either 0 to 150 volts or 0 to 300 volts at 5 milliamperes. Each model has a filament output voltage of 6.3 volts at either 3, 6 or 10 amperes, and is available in a universal type of construction whereby it can be used either as a 19" rack panel assembly or as a cabinet type assembly.

PATENT ABSTRACTS

Photographic copies of patent abstracts are being supplied by the *Picturesort Company* on a weekly basis as issued in the Official Patent Gazette. Abstracts are reproduced full size on 4" x 6" cards, punched for instant sorting, and the subscriber receives only the class and sub-class or type of patents in which he is interested. The cost is nominal and the saving of time in filing, finding, sorting and using may be substantial.

For more information, contact *Picturesort Company*, 246 Church Street, New Haven 10, Conn.

VARIAN LABORATORY

Varian Associates of San Carlos, California, developer and manufacturer of electronic products, is constructing a

(*Continued on page* 28)

Square Wave Generator

MODEL 71

SPECIFICATIONS

FREQUENCY RANGE: 5 to 100,000 cycles.
WAVE SHAPE: Rise time less than 0.2 microseconds with negligible overshoot.
OUTPUT VOLTAGE: Step attenuator giving 75, 50, 25, 15, 10, 5 peak volts fixed and 0 to 2.5 volts continuously variable.
SYNCHRONIZING OUTPUT: 25 volts peak.
R. F. MODULATOR: 5 volts maximum carrier input. Translation gain is approximately unity—Output impedance is 600 ohms.
POWER SUPPLY: 117 volts, 50-60 cycles.
DIMENSIONS: 7" high x 15" wide x 7½" deep, overall.

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
L-C-R Bridges
Megohm Meters
Megacycle Meters
Intermodulation Meters
TV & FM Test Equipment

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

NEW LITERATURE

TOOL STEEL HANDBOOK

"Tool Steel Handbook," a 197-page volume designed for engineers, teachers, metallurgists and others interested in tool, die and allied steels, has been published by *Allegheny Ludlum Steel Corporation*.

The material contained in this volume includes: charts and tables giving specific and comparative data on properties, analyses and applications; detailed descriptions of all important grades; the many forms and finishes of tool and die steels and allied products; discussions of heat treating and handling techniques; and a complete set of weight tables and other useful reference material.

Free copies will be sent to qualified persons on request to *Allegheny Ludlum Steel Corporation*, 2020 Oliver Building, Pittsburgh 22, Pa.

PORCELAIN SPECIALTIES

Various ceramic bodies used in the manufacture of electrical and electronic equipment are completely described in the 24-page brochure just published by *Star Porcelain Company*, Muirhead Avenue, Trenton, N. J. Containing suggestions for good ceramic design as well as data tables on physical properties and application information, the brochure also describes the research, engineering and production facilities behind the *Star* custom-made porcelain specialties.

"PHANTOM REPEATER"

The Model 102 "Phantom Repeater" is a bridging amplifier with an extremely high input impedance which is used to increase the accuracy of vacuum tube voltmeters and oscilloscopes on high impedance circuits.

A four-page bulletin describing this special test instrument has been released by *Keithley Instruments*, 3868 Carnegie Avenue, Cleveland 15, Ohio. In addition to listing complete specifications, the bulletin contains diagrams of typical applications, including simultaneous measurement of voltage, shape inspection, and aural monitoring with negligible loading of test circuits.

NBS RESEARCH ACTIVITIES

Established fifty years ago, the National Bureau of Standards has served both industry and science as the principal laboratory of the Federal Government in the major scientific fields of physics, mathematics, chemistry and engineering. NBS research and development activities are discussed in the feature article of the January issue of the Bibliography of Technical Reports, which may be purchased at 50 cents a copy from the Office of Technical Services of the U. S. Department of Commerce, Washington 25, D.C., or through the U. S. Department of Commerce field offices. Orders should be accompanied by check or money order payable to the Treasurer of the United States.

CARBONYL IRON POWDERS

General Dyestuff Corporation has issued a 32-page booklet covering the essential facts of production, application and performance of carbonyl iron powders. Containing a minimum of text, the booklet is studded with photomicrographs, charts, graphs, tables and pertinent mathematical formulas, and includes an extensive bibliography.

Copies are available on request to Department 99, *Antara Chemicals Division* of *General Dyestuff Corporation*, 435 Hudson Street, New York 14, N. Y.

X-RAY DIFFRACTION

A 60-page catalog entitled "X-ray Diffraction and Geiger-Counter X-ray Spectrometric Equipment" has been released by the Research & Control Instruments Division of *North American Philips Company, Inc.*, 750 South Fulton Avenue, Mount Vernon, N. Y. In addition to x-ray diffraction, spectrometry and fluorescence analysis, the catalog covers such components and accessories as tubes, rectifiers and cameras.

Information is also provided on applications for x-ray instruments, along with typical charts which show how specimens differ when analyzed by this powerful laboratory and production control equipment.

ELECTRONIC "BRAINS"

The complex electronic "brains" which control modern armaments are elaborate combinations of simple control devices called servomechanisms, or "servo systems." To develop competent service men for these electronic "brains," the Navy has prepared a "service-man's primer" on servomechanisms which is now available to the public.

This treatise, entitled "Instrument Servomechanisms," is devoted exclusively to servomechanisms used for automatic positioning. Known as PB 104 386, it contains 265 pages including diagrams, tables, photographs, and graphs, and sells for $2.00 a copy. Orders should be addressed to the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., and accompanied by check or money order payable to the Treasurer of the United States.

GRAPHICAL SYMBOLS

For the first time, single line diagrams for use in both power and communication work are combined in one volume. The American Standard Graphical Symbols for Single (One) Line Electrical Engineering Diagrams, Z32.-1.1.-1951, coordinates and modifies the single line diagrams contained in the American Standard Graphical Symbols for Electrical Power and Control, Z32.3-1946, and for Telephone, Telegraph and Radio Use, Z32.5-1944. Copies may be obtained from the American Standards Association, 70 East 45th Street, New York 17, N. Y., at $1.40 each.

RADIATION INSTRUMENTS

Publication of an eight-page, two-color bulletin containing essential information on ten recent nuclear radiation instruments has been announced by the *General Electric Company*, Schenectady 5, N. Y.

Designated as GEA-5735, this illustrated booklet covers the *G-E* radiation monitor, scintillation counter, portable radiation probe, area health monitor, long-probe gamma survey meter, alpha hand counter, air equivalent ionization chamber, boron-coated counter tube, thermocouple vacuum gage, and stepmotor impulse counter.

TECHNICAL DATA AVAILABLE

A condensation of the inventory of Department of Defense technical information activities has been published in Science magazine to acquaint scientists and engineers working in the National Defense Program with the current sources of available material.

A limited number of reprints of this article may be obtained from the Special Committee on Technical Information, Research and Development Board, Washington 25, D. C.

Application

(*Continued from page 9*)

the approximate gain and output impedance characteristics of the input stage used in an actual receiver, where crystal mixer and associated plumbing are located remotely from the i.f. input and connected through a low-impedance line.

The three staggered coils form a staggered triple with the first and last stages tuned above and below the midband frequency and the second stage tuned to the midband frequency and loaded to twice the bandwidth of the outer pair. The 47-ohm cathode compensatory resistor holds the input conductance of the a.g.c. controlled tubes constant over a wide range of a.g.c. voltage; hence the bandwidth does not change with signal level. Measurements showed that the gains per stage were from 16 to 20 db and were comparable to those obtained with a conventional amplifier operating at the same frequency and bandwidth.

A solder with a melting point slightly below the tin-lead eutectic was used in the construction of the unit to prevent injury to the bonding agent or laminate. Components are mounted so that they extend through the holes in the laminate, thus relieving the foil of the weight and tension a component might exert. After assembly, a coating of lacquer is used to protect the exposed etching from accidental shorting or scratching in servicing.

Conductive paint, solder, or wiring can be used between breaks in etched circuits without seriously impairing the operation of the unit.

The advantages of this method of construction are summarized as follows:

1. Units lend themselves to economical and rapid mass production techniques minimizing manual labor and wiring errors.
2. A uniform wiring layout reduces variations in performance from unit to unit.
3. Feedback problems in high-frequency applications are reduced.
4. Rigidity of coils and wiring improves stability of tuning under temperature and vibration.
5. Servicing and replacement are facilitated by the accessibility of the "two-dimensional" construction. Often repairs to damaged wiring can be made with solder or silver paint.
6. Conservation of copper and chassis metal is made possible.

A further refinement of the circuit can be seen by reference to Fig. 4. By use of combined resistor and condenser combinations commonly used in hearing aids and also in some of the newer television receivers, the total components added to the etched circuit could be reduced to one or two. Combining the cathode compensating resistor, the plate decoupling resistor and bypass capacitor in one unit, and the grid damping resistor, the a.g.c. decoupling resistor with its associated bypass condenser and the coupling condenser in a second unit would reduce the number of soldered connections from 14 to 7 per stage, thereby further reducing wiring errors, material costs and labor. Since i.f. stages of a single amplifier are in most cases identical except for the input and detector stage, these multiple units could not appreciably complicate the spare part requirements.

This work is but a step in the direction of a goal which may well result in the replacement of construction practices as we know them today, and in etched equipment which is cheaper and smaller, lighter and more durable than that used at present.

Printers

(*Continued from page 7*)

This printer differs from a conventional printer in that the squeegee remains stationary. As the control lever is brought forward, the mandrel, bearing the cylinder to be printed, rises to meet the stenciled screen. Simultaneously the squeegee, which is directly above the mandrel, drops to press against the top surface of the screen. The screen, which remains flat and horizontal at all times, then starts to move (forward on one stroke, backward on the next) over the cylinder, and the cylinder rotates in response to the horizontal motion of the screen pressing against it. While the cylinder rolls against the screen, the squeegee forces conducting paint onto the cylinder through the pervious pattern of the screen. When the cylinder has made one complete revolution, both cylinder and squeegee are moved away from the screen. As the control lever is moved back to its starting position, the mandrel carrying the cylinder is rotated from a horizontal to a downward position, a release mechanism on the mandrel is actuated, and the printed cylinder drops off.

With hand loading of the cylindrical surface printer, an operator can easily print 1500 cylinders in an 8-hour day. An automatic feed mechanism and electric drive, which could be added without much difficulty, should increase the production rate to a probable 500 or 1000 cylinders per hour. For fully automatic production at high speed, a conveyor belt system with steadying pins could also be added to carry away the printed cylinders.

IT'S PRECISION
HIGH on the list of important reasons for selecting Bliley Crystals is precision. From research, thru development and production, this keynote is emphasized. Precision built Bliley Crystals are a must for the precision performance of your equipment.
Bliley
CRYSTALS
BLILEY ELECTRIC COMPANY
UNION STATION BUILDING
ERIE, PA.

Personals

JAMES DALE is the new chief TV and radio engineer at *Hoffman Radio Corporation*, Los Angeles, Calif. On the engineering staff since January, 1951, his promotion was part of a recent revamping of the organization setup. Prior to joining the *Hoffman Radio Corporation*, Mr. Dale spent five years with *Motorola, Inc.*, as project engineer, and was associated with *Belmont Radio Corporation* for 13 years in a similar capacity.

ROBERT DRESSLER, who has been in charge of various aspects of television research for *Paramount Pictures Corporation* for the past five years, was recently appointed director of research and development for *Chromatic Television Laboratories, Inc.*, New York, N.Y. Mr. Dressler's new responsibilities will include projects for the Armed Services, theater television and color television cathode-ray tubes and systems.

KENNETH A. HOAGLAND has been appointed assistant engineering manager of the Cathode-ray Tube Division at *Allen B. Du Mont Laboratories, Inc.*, Clifton, N. J., where he will be in charge of the design and development of cathode-ray tubes. Mr. Hoagland is credited with the development of the *Du Mont* "bent gun" and the new "selfocus" picture tube. An outstanding tube expert, he is well known for his technical articles in various trade journals.

GEORGE W. JERNSTEDT, presently in charge of Electroplating Projects at *Westinghouse Electric Corporation*, Pittsburgh, Pa., has been appointed manager of engineering for the Special Products Development Division as well. Mr. Jernstedt joined the Meter Division of *Westinghouse* in 1936 while he was still an undergraduate at the Newark College of Engineering. He later obtained his master's degree in chemical engineering from Michigan State College.

WALTER E. KINGSTON is the director of the new Atomic Energy Division of *Sylvania Electric Products Inc.*, Bayside, N. Y. He will head Sylvania's expanded program of research and development in the field of nuclear reactor materials for the U. S. Atomic Energy Commission. Formerly manager of *Sylvania's* Metallurgical Laboratories, Mr. Kingston has acquired an international reputation for his researches in powder metallurgy.

HOMER R. OLDFIELD, Jr., newly-appointed resident manager of the *General Electric* Advanced Electronics Center at Cornell University, Ithaca, N. Y., has been with *G-E's* Electronics Division since 1945. Active in World War II, Mr. Oldfield was awarded the Legion of Merit by the Army for his part in developing microwave fire control radar, and the Citation Ribbon from the Air Force for similar work on airborne radar equipment.

News Briefs

(*Continued from page 25*)

million-dollar research and development laboratory at Palo Alto on land leased from Stanford University.

The new *Varian* building, which will provide more than 30,000 square feet for expansion of the company's facilities, will contain electronic tube and special products development laboratories, drafting, machine shop, plating, testing and assembly facilities, and administrative offices. The company's present plant in San Carlos is being retained, and will be devoted entirely to manufacturing.

TEMPERATURE MONITOR

A temperature monitoring device was recently developed by Messrs. M. L. Greenough, F. H. Bayhe, Jr., and Melvin Martens of the National Bureau of Standards Electronic Instrumentation Laboratory, which flashes a warning if the temperature at any one of 48 remote points rises above an individually predetermined safe value.

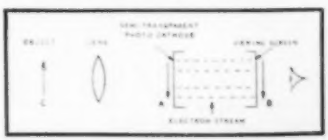
Image Converter

(*Continued from page 13*)

one millisecond was used and nine pictures of a propellor rotating at 3600 rpm were taken in less than 1/100 second. Messrs. Chippendale and Jenkins of the *Mullard Laboratory* believe that this technique is potentially one of the most important applications of image converters. It can be successfully combined with the high speed cine camera technique to give an effective multiplication of 10 to 25 on existing frame rates.

The *Mullard* ME 1201 image converter was designed for use with a Wray f/1 lens recording from the luminescent screen. This lens adequately covers the 4-in. diameter screen reducing 4:1 onto 35-mm. film. To record exposures at 1/10 microsecond (10^{-7} sec.) it is necessary to use high speed film. When this is processed to give maximum film speed, the resolution is limited by the grain size. Resolutions of slightly better than 600 lines per picture are normally possible with the fastest emulsions.

Diagram showing the optical system and electron flow in the image converter.



New Products

(Continued from page 23)

values, write to *Magnetic Amplifiers, Inc.*, 11-54 44th Drive, Long Island City 1, N. Y.

DIRECT-READING FREQUENCY METER

Now in production at *Gertsch Products, Inc.*, Los Angeles, Calif., is Model

FM-1A, a new v.h.f. frequency meter which was designed to provide a direct method of measuring or generating any frequency from 20 to 480 megacycles; frequency is read direct from a dial, without the use of a calibration book. Provision has been made to modulate the carrier frequency at a minimum of 30% at 1000 cycles.

Model FM-1A employs a unique and original circuit utilizing an extremely accurate 1.0 megacycle crystal, with variable capacity trimming to allow exact adjustment. All frequency measurements are referenced to the crystal, which has a temperature coefficient of 0.0001% per degree C.

OUTPUT TRANSFORMER

Excellent frequency response, high power-handling capacity, a high degree of astaticism, and flexibility of impedance ratios have been combined in a convenient, compact unit in the Type 942-A toroidal output transformer developed by the *General Radio Company*,

275 Massachusetts Avenue, Cambridge 39, Mass.

Leakage reactance between primary sections is very small to give minimum distortion from switching transients in conventional push-pull circuits, and connections to individual primaries are provided for certain single-ended push-pull circuits.

In addition to its use in regular audio amplifiers, this transformer is well adapted for use in high power modulators, and in amplifiers for electronic musical instruments and constant-voltage audio distribution systems.

SUB-MINIATURE TUBE SOCKETS

Mycalex Tube Socket Corporation now offers a complete line of sub-miniature tube sockets, designed for high efficiency service in electronic equipment where space is at a premium. These compact sockets mount without screws or rivets in shaped chassis holes.

Improved electrical performance and greater mechanical protection for the tube are provided through the use of "Mycalex 410," injection-molded, glass-

bonded mica for the socket body, than would be possible with ordinary insulating materials.

These tube sockets are available with cadmium-plated brass contact terminals or silver-plated beryllium copper terminals, assuring low contact resistance, freedom from corrosion and ease of soldering. Complete information will be supplied on request to *Mycalex Tube Socket Corporation*, 30 Rockefeller Plaza, New York 20, N. Y.

GAIN SET

An a.c. operated, rack-mounted Type 12A transmission measuring or gain set has been designed for the measurement of voice transmission systems by the *Daven Company*, 191 Central Ave., Newark, N. J. The source output and receive input of the gain set are 600-ohm balanced circuits provided with d.c. blocking capacitors so that the equipment will not interfere with the normal operation of modern dial systems.

Controls are provided on the front panel for adjusting the 1000-cycle fre-

LEEDS Our 29th Year
QUALITY – PRICE DEPENDABILITY

POLYSTYRENE

ROD 12" LENGTHS

O.D.	Price	O.D.	Price
1/8	$ .03	3/4	$ .80
3/16	.06	7/8	1.15
1/4	.10	1	1.55
5/16	.16	1 1/4	2.30
3/8	.21	1 1/2	3.30
1/2	.40	1 3/4	4.50
5/8	.57	2	5.90

TUBING 12" LENGTHS

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TECHNICAL BOOKS

"THE RECORDING AND REPRODUCTION OF SOUND" by Oliver Read, Editor of RADIO & TELEVISION NEWS and RADIO-ELECTRONIC ENGINEERING. Second Edition. Published by *Howard W. Sams & Co., Inc.*, Indianapolis 5, Ind. 790 pages, 700 illustrations. $7.95.

The second edition of this reference manual has been greatly enlarged and expanded to make it an invaluable source of information for engineers and hobbyists in all branches of audio. Emphasis throughout is on a complete, lucid presentation of the subject matter.

Subjects covered include basic concepts; disc recording and reproduction, including microgrooves; magnetic recording; equalizers and tone controls; amplifiers; complete music, PA and recording systems; and audio measurements. Detailed information on commercial equipment is included wherever practicable. The last chapter presents the NARTB recording and reproducing standards, and a glossary of terms.

The appendix contains a wealth of miscellaneous data such as mathematical tables, color codes, bibliography of magnetic recording, nomographs, charts and mathematical formulas.

This is a standard reference work which should be on every engineer's bookshelf.

"SHORT-WAVE RADIATION PHENOMENA," in two volumes, by August Hund, Scientific and Technical Radio Consultant. Published by *McGraw-Hill Book Company, Inc.*, 330 West 42nd Street, New York 18, N. Y. 1382 pages. $20.00.

Reflecting the author's more than 37 years of experience in the field, these volumes contain an abundance of data, formulas, and theory on short-wave radiation effects. They discuss the useful applications of short-wave radiation phenomena as well as both standard and recently developed propagation theory.

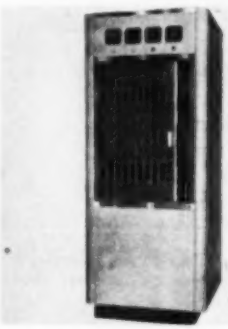
Consisting of nine large sections, the two volumes together constitute one book, and are not sold separately. Among the topics covered are: fundamental concepts and relations of currents and electromagnetic fields; space electromagnetic fields of elementary electric and magnetic dipoles; fundamental methods used in electromagnetic theory; propagation characteristics; transmission lines and radiation; unobstructed space radiation; and space radiation in the presence of electromagnetic obstructions.

quency over a range of ± 30 cycles, and for adjusting the oscillator level output

to the red line of the meter. Errors due to internal distortion of the tube circuits are eliminated by filters, located at the front end of the amplifier, which provide four frequency response curves.

COMPACT AM TRANSMITTER

The new one-kilowatt AM broadcast transmitter which has been announced by the *RCA* Engineering Products Department, Camden, N. J., is less than half the size of its predecessor and features a single tuning control. Streamlined mechanical construction and improved circuits and components throughout reduce power consumption by approximately one-fourth, *RCA*

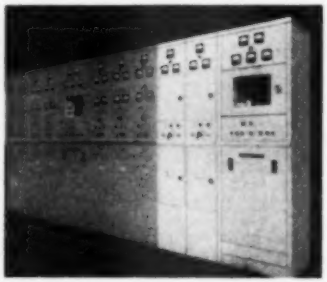


stated, and afford economies in space as well as in operation and maintenance costs.

LOW/MEDIUM FREQUENCY TRANSMITTER

A new type MW low/medium-frequency transmitter is available from *Westinghouse Electric Corporation* for fixed station operation. It is intended for use in public service communications, communications services operated by private companies and airlines, government services, and radio beacon service. In accordance with FCC requirements, the unit is adaptable to facsimile and frequency-shift keying types of emission in addition to c.w., m.c.w., and phone.

The design of this equipment represents a new approach to the problem encountered in using large inductors



and capacitors at the low frequencies. The type MW transmitter uses iron-core transformers for the low and medium frequencies which are small in size and eliminate the necessity for tank-circuit tuning.

For further information, write *Westinghouse Electric Corporation*, Box 2099, Pittsburgh 30, Pa.

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CALENDAR of Coming Events

MAR. 31-APR. 2—Sixth Annual NARTB Broadcast Engineering Conference, Conrad Hilton (Stevens) Hotel, Chicago, Ill.

APRIL 15-17—AIEE South West District Meeting, Jefferson Hotel, St. Louis, Mo.

APRIL 19—IRE Cincinnati Spring Conference, Engineering Societies Bldg., Cincinnati, Ohio.

MAY 5-7—RTMA, AIEE, and IRE sponsored government—industry conference on Quality Electronic Components, Washington, D. C.

MAY 8-10—Acoustical Society of America 43rd Meeting, Hotel Statler, New York, N. Y.

MAY 10—IRE New England Radio Engineering Meeting, Copley Plaza Hotel, Boston, Mass.

MAY 12-14—IRE National Conference on Airborne Electronics, Hotel Biltmore, Dayton, Ohio.

MAY 16-17—Fourth Southwestern IRE Conference and Radio Engineering Show, Rice Hotel, Houston, Texas.

MAY 19-22—Radio Parts and Electronic Equipment Show, Conrad Hilton Hotel, Chicago.

AUGUST 27-29—IRE Western Convention, Municipal Auditorium, Long Beach, Calif.

Toroidal Coil

(*Continued from page 6*)

when changing from one size to another.

The machine weighs approximately 300 pounds and is designed for bench operation with over-all dimensions of 18" in width, 24" from front to rear, and 14" in height.

Fig. 4 shows a variety of toroidal coils which can be wound on the *Boesch* type of machine.

Another type of machine, known as the "Micafil" type, is manufactured by *Micafil Ltd.* in Zurich, Switzerland, and is marketed in the United States by the *Coss Corporation*. This machine can wind either a sector or 360°. A geared ring goes through the toroidal core which is engaged for rotation, precluding inner diameters of less than 9/16" for the smallest size version. The smallest size machine for handling the smallest toroidal coils has the following specifications:

1. Maximum outer diameter of 3⅛", minimum outer diameter of 1¼", and minimum inner diameter of 9/16".
2. Wire sizes that can handle 23 to 34 AWG, wire being under tension.
3. Maximum shuttle speed of 200 rpm while winding.
4. Shuttle capacity of 1¾ ounces copper wire.

A third type of machine is the *Harder* development, evolved by Donald Harder of San Diego, California. The original version of this machine was known as the "NEL" winder, as it was based on initial work done at the Navy Electronics Laboratory by Mr. Harder and other employees. In this machine, a hollow split ring is manually forced open and placed through the core. Wire is then unwound from a spool into the semi-opened ring. When the hollow ring bobbin is full, or contains sufficient wire to wind one coil, it is reversed and unwound on the core, rotating by frictional contact against a motor drive. This machine can wind up to 360°, but rotating the coil to control deposit of lay is done manually by approximation. An electronic counter operates with each rotation of the split ring bobbin and has minimum tension, or virtually no tension, on the wire. This permits the use of very fine wire, such as No. 44, at high winding speeds over 1000 rpm. The minimum inner diameter of the coil is limited only by the outer diameter of the split ring bobbin. Holes with less than a ¼" diameter can be handled by use of a split ring having a thickness of less than that dimension.

Several manufacturers of toroidal coils have constructed their own winders, approximating methods described for the three types mentioned above.

Although greater progress could be made in the radio art if simpler, quicker, and cheaper means existed to wind toroidal coils, the manufacturers of existing designs are to be congratulated for their achievements to date. Present machines embody patentable inventions and more are likely to emerge as efforts are made to wind more coils in less time in a single unit of equipment handled by a single person. The machines described herein have greatly reduced the price and improved the availability of these toroidal coils so that they are rapidly encountering increased acceptance and utilization afield.

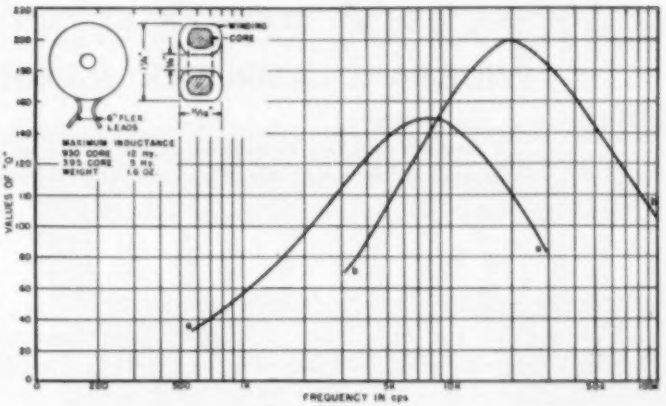

Fig. 10. Q vs. frequency for wedding ring toroid. Curve a—930 core; curve b—395 core.

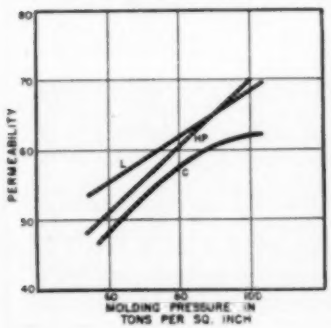

Fig. 8. Permeability vs. molding pressure for carbonyl iron powders.

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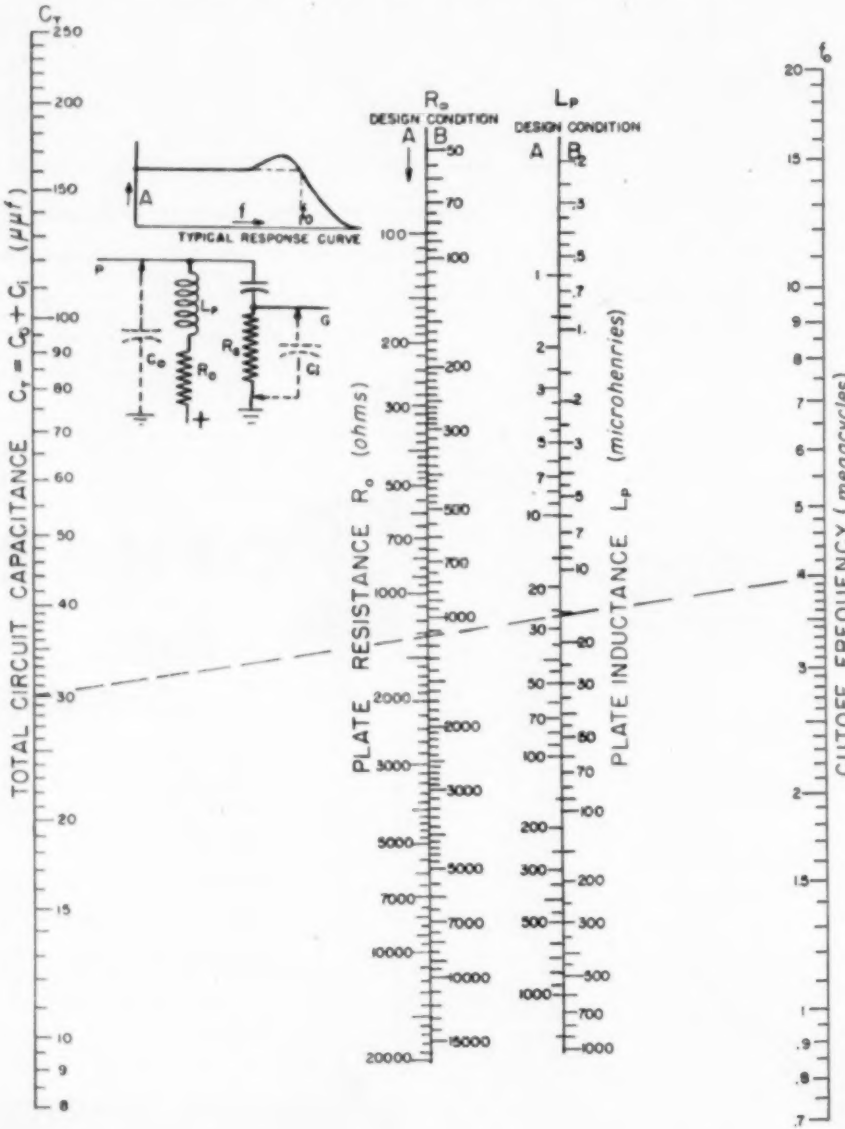
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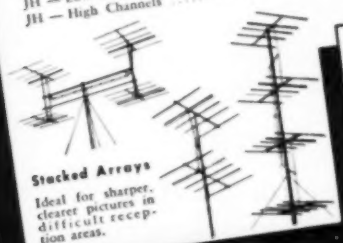

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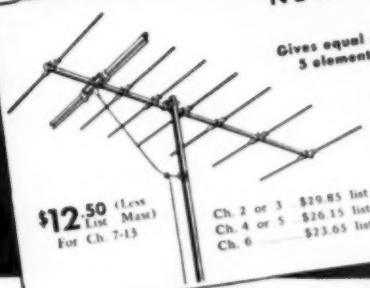

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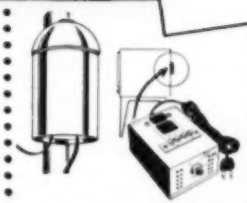

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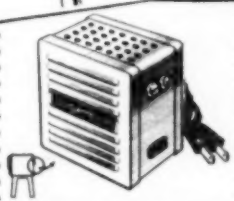

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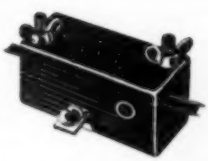

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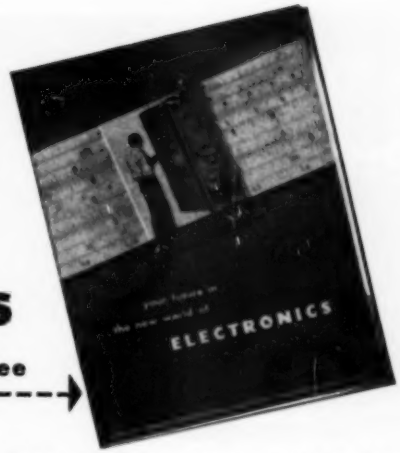

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There are 109 TV stations now on the air. The FCC's chairman predict 1500 stations within 5 years, and 2500 stations by 1961. Already it is estimated there are 15,690,394 TV sets and over 100,000,000 radios in operation. How these figures will increase in the next few years, the most daring experts are reluctant to predict. This much is certain: Limitless numbers of positions must be filled—in development, research, design, production, testing, inspection, manufacture, broadcasting, telecasting, and servicing. To fill these posts, trained men are needed—men who somewhere along the line are alert enough to improve their knowledge and skills.

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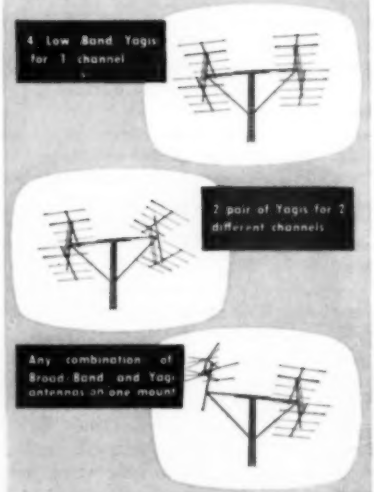
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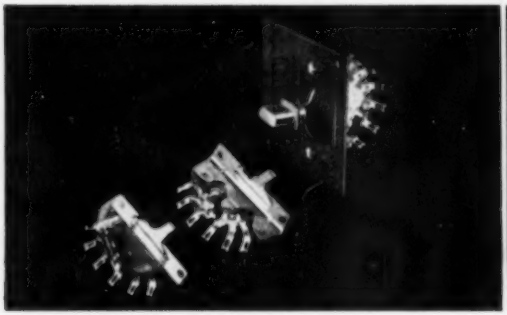

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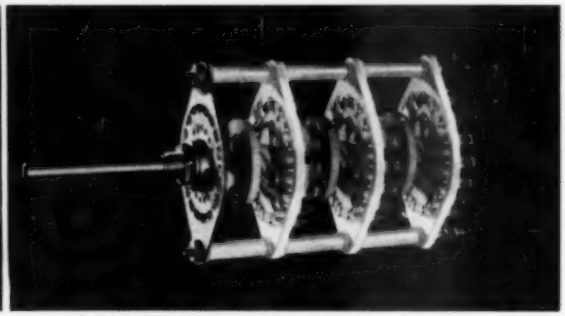

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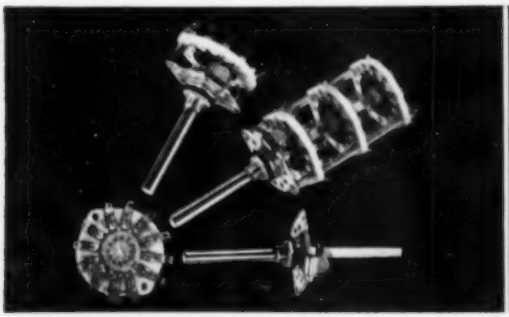
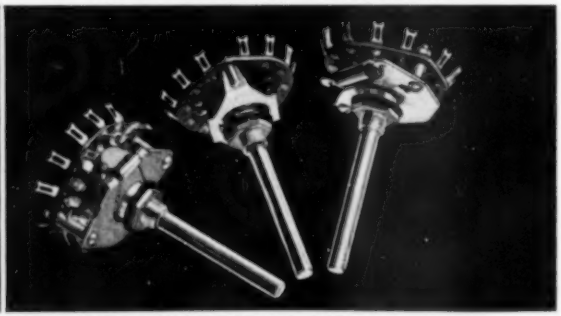
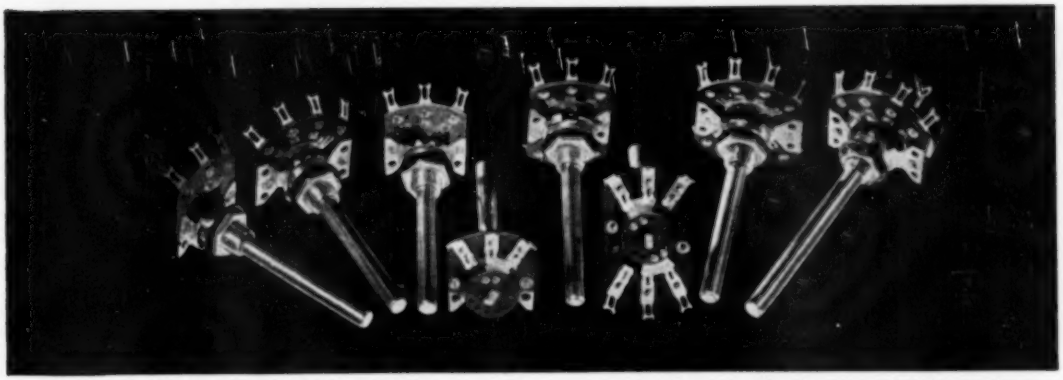


ROTARY SELECTOR SWITCHES — for use in fast, positive band switching in critical radio frequency circuit applications — in the oscillator, buffer or final amplifier stages of transmitters with input up to 75 watts and plate voltages up to 850 v.d.c. Also amateur rigs, test equipment and low current switching. Steatite or phenolic insulation.



ROTARY ACTION FLAT SWITCHES—for program switching — monitoring, transceivers, band change, P. A. and intercoms. Phenolic insulation. Cadmium plated metal parts. A 4-pole, 2-position, non-shorting type with positive leaf spring index. Can be used a SPST, SPDT, DPST, DPDT, 3PST, 3PDT, 4PST or 4PDT.

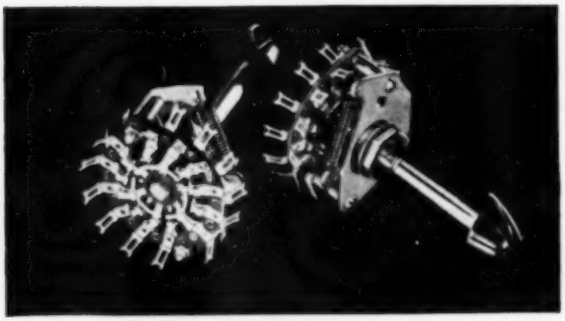
time and money to buy



SMALL GENERAL PURPOSE SWITCHES—on-off and step control switches for radio, P. A. channel selectors, wave band, meter reversing, meter selector, intercom talk-listen, momentary line or remote speaker return and dual auto radio speaker control. Clips and contacts heavily silver plated. Phenolic insulation. SPST, SPDT, DPST, DPDT, etc.

414-419 ROTARY SWITCH KITS—give you a convenient, easily available source of stock sections, indexes and hardware for assembling practically any standard or special switching arrangement desired. Contain Centralab "DD" Index and Section construction. Attractive steel cabinet, fits standard steel shelving. 17" x 11 13/16" x 12 3/4".

1500 SELECTOR SWITCH KIT — ideal convenience for labs, design and service engineers, industrial electronic maintenance departments, hams and experimenters. 33 standard rotary switch phenolic sections, 16 index assemblies and adequate supply of flat shafts, spacers, nuts, bolts, lockwashers and knobs. 8" x 8" x 7".



INTERCOM SWITCHES — for public address and intercom talk-listen systems. Six pole, 3 position. Available in two types — spring return from both sides to center and spring return one side, positive opposite side. For long, hard use in industrial test equipment. They are Centralab De luxe, "DD", style.

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MERIT "TV" Kit #1000 for edge to edge focus—contains MDF-70 Cosine Yoke, HVO-7 Universal Flyback and MWC-1 Width Linearity Control. Keep a Kit handy — you'll get plus business and a reputation for "know-how."

MDF-70 . . . original of the "cosine" series — low horz, high vert inductance. Used by such famous sets as Radio Craftsmen. Cosine Yokes will improve 10,000,000 sets now in use!

MERIT...HQ for TV Service Aids

MERIT's 1952 Catalog #5211 now available . . . introducing MERIT IF-RF Coils, includes Coil & Transformer data, listings. Other MERIT service aids: TV Repl Guide #404, Sept. '51 issue—covers 3000 models, chassis of 82 mfrs; Cross Ref Data on IF-RF Coils, Form #14. Write: Merit Coil and Transformer Corporation, 4425 North Clark Street, Chicago 40.

These three MERIT extras help you:

- **Exclusive: Tape-marked with specs and hook-up data**

- **Full technical data packed with every item**
- **Listed in Howard Sams Photofacts**

***Merit is meeting the TV improvement, replacement and conversion demand with a line as complete as our advance information represents!**

SCHEDULE THROUGH ADVERTISING

Within the INDUSTRY

JOHN H. BOSE, an engineer associated with Edwin H. Armstrong, has been elected president of the Radio Club of America for 1952.

Other officers elected to serve during the coming year include: Vice-President Ralph R. Batcher, engineer for the Radio-Television Manufacturers Association; Corresponding Secretary Frank H. Shepard, Jr., president of *Shepard Laboratories;* Recording Secretary Frank A. Gunther, vice-president of *Radio Engineering Laboratories, Inc.;* and Treasurer Joseph Stantley, president of *Continental Sales Company.*

The following men were elected to serve on the board of directors: Ernest V. Amy, Edwin H. Armstrong, George E. Burghard, Alan Hazeltine, Harry W. Houck, Jerry Minter, and Harry Sadenwater.

* * *

LAWRENCE R. COHEN has been named sales manager for Army Equipment for the Electronics Division of *General Electric Company.* He will handle the division's sales to all branches of the Department of the Army.

George C. Trotter received a similar appointment as sales manager for Air Force equipment. Both men will headquarter at Electronics Park in Syracuse.

Mr. Cohen is a graduate of Brooklyn College and served with the U.S. Signal Corps from 1943 to 1946. Serving principally at the Signal Corps center at Fort Monmouth, he also attended radar schools at Harvard and MIT. He has been with *G-E* since 1946.

Mr. Trotter attended Harvard and served as a Lieutenant (jg) in the electronics group of the Navy's Bureau of Aeronautics from 1942 to 1945. He has been associated with *G-E* since 1948.

* * *

ELECTRICAL REACTANCE CORPORATION has been formally merged with *Aerovox Corporation* and will henceforth operate as the "Hi-Q" Division of *Aerovox,* Olean, New York.

In the fall of 1949, the *Aerovox Corporation* purchased all of the outstanding common stock of the *Electrical Reactance Corporation* and the present merger of the two companies into one is being made in the interests of closer cooperation with the parent company and increased efficiency.

Charles E. Krampf will continue as vice-president of the *Aerovox Corporation* and will be directly responsible for the operation of the new division. Tom Conway, general manager of the merged company, will continue as general manager of the new division.

* * *

KING P. RAY is the new field sales manager for *Stewart-Warner Electric,* the radio and television division of *Stewart-Warner Corporation.*

In his new position, Mr. Ray will be responsible for the general marketing problems and field work at the distributor level under the expansion program of the company's television and radio division. The position of field sales manager is a newly-created one. He will make his headquarters in the general offices of the company in Chicago.

Prior to joining the company, he served as assistant to the vice-president of *Daystrom Corp.* of Chicago.

* * *

DR. ALAN HAZELTINE has been named president of the Alexander C. Humphreys Foundation.

The Foundation was organized a year ago to honor and perpetuate the memory of the late Dr. Alexander C. Humphreys, utilities executive and second president of Stevens Institute of Technology, who introduced courses which constituted the first approach to management engineering made by any engineering college.

The first goal of the Foundation will be to raise funds to fully endow professorships in Economics of Engineering.

Dr. Hazeltine is a graduate of Stevens, taught electrical engineering at the college from 1907 to 1925, and physics and mathematics from 1933 until 1944. He is famous for his invention of the neutrodyne radio receiver and as a consultant in radio-electronics.

* * *

HANS U. HJERMSTAD is the newly-elected vice-president in charge of engineering for *Sola Electric Company* of Chicago.

He has been in charge of engineering development for the company since 1948 as assistant to the president. He will continue to head *Sola's* engineering department and engineering laboratory which develops new product designs and applications in industry for the company's transformer products.

Prior to his association with *Sola,* Mr. Hjermstad was affiliated with *Federal Electric Company* as vice-

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TUBES ARE KNOWN BY THE COMPANY THEY KEEP

It's automatic with scores of top-flight manufacturers. They turn to CBS-Hytron for the miniature OA2, OB2 and standard OC3, OD3.

That's only natural. They know CBS-Hytron has the know-how . . . know-how gained from making over 15,000,000 voltage regulators. They know CBS-Hytron supplies these apparently simple tubes to either JAN or commercial specifications. (In fact, CBS-Hytron's factory tests of VR tubes are much tougher than JAN.) And they know CBS-Hytron . . . top producer of VR tubes . . . can be depended upon for prompt delivery.

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CBS-HYTRON voltage-regulator tubes

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MAIN OFFICE: Salem, Massachusetts

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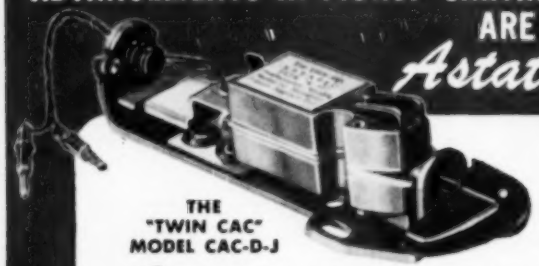
In addition **to many other prominent manufacturers, the U. S. Army, Navy, Air Force, Coast Guard, AEC, CAA, FCC, National Bureau of Standards, government development laboratories and other government agencies, well-known research laboratories and universities, foreign countries, and the nation's leading electronic parts distributors.**

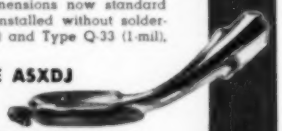
THE LATEST AND THE GREATEST ADVANCEMENTS IN PICKUP CARTRIDGES ARE *Astatic*



THE "TWIN CAC" MODEL CAC-D-J

FITS MOST of the popular changers. The first turnover design to remove all obstacles preventing true perfection of reproduction. Combines two complete CAC cartridge assemblies, back to back, on a common plate. Output and response characteristics of each side established independently of the other. Needles are also, of course, entirely independent of each other, free of interaction. Unique but simple switching device in turnover mechanism connects only the cartridge or side being used to amplifier phonograph input. Furnished complete with turnover bracket and knob assembly, with standard ½" mounting holes. Wiring terminating in pin connectors, graduated for two dimensions now standard on lead wire connectors. Easily installed without soldering. Equipped with Type Q (3-mil) and Type Q-33 (1-mil), sapphire-tipped needles.

LIST PRICE $10.50 CODE ASXDJ



ONE OF THE THREE NEW ASTATIC TURNOVER PICKUPS EQUIPPED WITH THE TWIN CAC CARTRIDGE IS A SPECIAL MODEL, THE 9-D, LISTING AT ONLY $11.50, IT IS DESIGNED FOR REPLACEMENT ON V-M MODELS 920, 950, 955, 970, 971, 975, 980 AND 985. REPLACE THE ENTIRE TONE ARM —EASILY, QUICKLY, WITH ONLY A SCREWDRIVER—FOR THE THRILLING NEW PERFECTION OF REPRODUCTION WHICH THE TWIN CAC CARTRIDGE MAKES POSSIBLE.

THE MODEL L-12-U

LEAVE condenser harness on for low output (1.2 volts) . . . or slip it off for high output (4.0 volts) . . . and you can replace most standard 78 RPM cartridges with this single model. Reproduction guaranteed to better or equal the previous unit. Needle chuck limiting feature restricts motion of the chuck both radially and lengthwise, prevents dislocation of chuck, and protects against crystal breakage from rough handling and when changing needle. Furnished with complete installation instructions and listing of cartridges the L-12-U replaces.

LIST PRICE $4.95 CODE ASWSF

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Cable Address: ASTATIC, New York

president in charge of research, engineering, and manufacturing.

* * *

FEDERAL TELEPHONE AND RADIO CORPORATION has established a mobile radio communications department for the design, manufacture, sale, and servicing of a complete line of vehicular and railroad mobile radio equipment. The new department will operate at *Federal's* newly-acquired plant in Passaic, New Jersey . . . **LION MANUFACTURING CORPORATION,** well-known Chicago manufacturer of electrical devices, will unveil its line of television receivers at the Parts Show in Chicago during May and officially enter the market during the Chicago Furniture Market held in July . . . **SYLVANIA ELECTRIC PRODUCTS INC.** has purchased the cabinet plant of **BLAIR PARK FURNITURE MFG. COMPANY** at High Point, N. C. The 55,000 square foot plant will operate as part of the parent company's Radio & Television Division . . . **BECKMAN & WHITLEY INC.,** San Carlos, California instrument-engineering organization, has established a new guided missile products division . . . **LOU F. WAELTERMAN** has established a new manufacturers' representative firm which has headquarters at 8543 McKenzie Road, St. Louis 23, Missouri.

* * *

IRVING G. ROSENBERG has been named director of operations, responsible for *Allen B. Du Mont Laboratories, Inc.'s* television receiver and cathode-ray tube divisions.

Mr. Rosenberg has been manager of *Du Mont's* cathode-ray tube division since 1946 and actively supervised its growth and expansion. He has been with the company since 1942, starting in production control.

He will make his headquarters at the company's East Paterson, N. J. plant.

* * *

STANDARD COIL PRODUCTS CO. INC. and *General Instrument Corporation* have agreed to an exchange of stock at the rate of five shares of *General Instrument* for four shares of *Standard Coil.*

Standard Coil plans to operate *General Instrument* as a wholly-owned subsidiary. The parent company has plants in Chicago; Los Angeles; Bangor, Michigan; and through another subsidiary, *Kollsman Instrument Corporation,* in Queens, N. Y.

General Instrument has plants in Elizabeth, New Jersey; Chicopee, Mass.; and Joliet, Illinois.

* * *

KEPCO LABORATORIES, INC. will house its production, research, and development facilities in an ultra-modern plant, now nearing completion in Flushing, New York . . . **TUNG-SOL SALES CORPORATION** has moved from Los Angeles to 857 Washington Boule-

(*Continued on page* 120)

Makeshift Replacements Reduce Picture Quality

Replacements with
Raytheon Television Tubes
assure picture quality

Don't forget! **Raytheon Picture Tubes with Corona Inhibitor give constant picture clarity whatever the weather.**

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6 PRACTICAL AIDS TO MAKE YOUR SERVICE JOB EASIER!

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5.

6.

1. Radio and TV Service Manuals

Four separate volumes of service notes on AM home and portable receivers, FM and TV receivers, and radio-phonos. The books contain complete service manuals on G-E radio and TV sets for the years 1946 through 1952. Also schematics, parts lists, alignment procedures, electrical and mechanical specs, etc.

2. G-E TV Receiver Service Guide

Brand new—80 pages packed with information on all G-E television receivers built since 1945—102 models! Contains schematic diagrams, replacement parts list, tube and component layouts, picture tube assembly adjustments, cabling of combination receivers, R-F tuner units, and top and bottom chassis views.

3. TV Principles and Practice

A complete course in itself—for the trained serviceman. Each chapter is a separate booklet of standard office file size. Fifteen in all, they cover practical applications of TV receivers of the post-war period, together with a detailed description of modern test equipment; TV antennas and trouble shooting techniques.

4. Bound Volume 1939-1942

Here are all the individual manuals for G-E portable and home receivers manufactured during the years from '39 to '42 inclusive. AM home and portable receivers, FM sets, TV receivers and radio-phono combinations. Schematic diagrams, electrical and mechanical specs, parts lists, etc.—all in one binder.

5. TV and Radio Parts Catalog and Price List

Lists the parts of every G-E radio and TV receiver manufactured since October, 1945. In this book you will find all the information you need about any part—catalog number, description, sets in which it is used, and price. Practical, hard cover, loose-leaf pages.

6. FM Principles and Practice

Special effort has been made in this booklet to acquaint the serviceman with the important differences between AM and FM. Circuit descriptions are particularly complete. Useful information on antenna theory, plus pointers on how to choose antenna location and how to calculate antenna length.

HOW TO GET THEM—Your General Electric receiver distributor is the man to call. He will see to it that you get the aids you need to make your servicing more profitable. Why not ask him today? *General Electric Company, Receiver Department, Syracuse, New York.*

You can put your confidence in—

GENERAL ELECTRIC

GET YOUR NEW hallicrafters

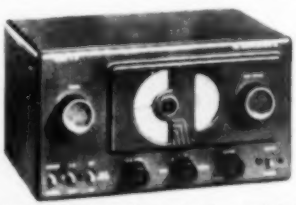
COMMUNICATION RECEIVER HERE and

Save Money With a "Surprise" Trade-In Allowance on Your Used Test and Communication Equipment

For super dooper savings on Hallicrafters Receivers get a Walter Ashe "SURPRISE" Trade-In offer on your used (factory-built) Test Instruments or Communication Equipment. Walter will give you an extra-liberal allowance that will put the Hallicrafters model of your choice within easy reach! So don't delay! Get your trade-in deal working today. Wire, write, phone or use the handy coupon below.

Wherever You May Roam ... on Land or Sea

HALLICRAFTERS SX-71—Shpg. wt. 33 lbs. Only $199.50
(Less speaker). R-46 speaker, 19 lbs. . . . . Only $19.95



HALLICRAFTERS S-38B—Shpg. wt. 14 lbs. . . Only $49.50

Keep The Home Ties With The S-72, Long-Range Portable

Soldier, sailor, marine, businessman, diplomat, world traveler, explorer—wherever you are . . . no matter where you go . . . you'll always be just "around the corner" from home with this extra-sensitive, portable broadcast-short wave radio. Plenty of sensitivity for far-distant stations, even where ordinary receiving sets fail. Can be used on 110-120 volt AC or DC, or self-contained batteries. Covers 540KC. To 30MC.

Shpg. wt. 16 lbs.
Only $109.95 (less battery)

Battery Pack for S-72
(Shpg. wt. 8½ lbs.) $4.17

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Learn RADIO TELEVISION

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NO MONTHLY PAYMENT CONTRACT TO SIGN!

I Send You 18 BIG KITS OF RADIO-TELEVISION EQUIPMENT

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TRAIN IN 10 MONTHS OR LESS

At Home in Your Spare Time

Now . . . be ready for Radio-Television's big pay opportunities in a few short MONTHS! Frank L. Sprayberry's completely new "Package" training unit plan prepares you in just 10 MONTHS . . . or even less! Equally important, there is NO monthly payment contract to sign . . . thus NO RISK to you! This is America's finest, most complete, practical training—gets you ready to handle any practical job in the booming Radio-Television industry. In just 10 months you may start your own profitable Radio-Television shop . . . or accept a good paying job in this fascinating expanding field at work you've always wanted to do. Mr. Sprayberry has trained hundreds of successful Radio-Television technicians—and stands ready to train you in less than one year, even if you have no previous experience. You learn by DOING . . . actually working with your hands with equipment of special design to illustrate basic theory instead of relying on books alone.

VALUABLE EQUIPMENT INCLUDED WITH TRAINING

The new Sprayberry "package" plan includes many big kits of genuine, professional Radio-Television equipment. While training you actually perform over 300 demonstrations, experiments and construction projects. In addition, you build a powerful 6-tube standard and short wave radio set, a multi-range test meter, a signal generator, signal tracer, many other projects. All equipment is *yours to keep* . . . you have practically everything you need to set up your own service shop. The interesting Sprayberry book-bound lessons and other training materials . . . all are yours to keep.

EARN EXTRA MONEY WHILE YOU LEARN!

All your 10 months of training is AT YOUR HOME in spare hours. Keep on with your present job and income while learning . . . and earn EXTRA CASH in addition. With each training "package" unit, you receive extra plans and ideas for spare time Radio-Television jobs. Many students pay for their entire training this way. You get priceless practical experience and earn generous service fees from grateful customers. Just one more reason why the Sprayberry new 10 MONTH-OR-LESS training plan is the best Radio-Television training in America today. If you expect to be in the armed forces later, there is no better preparation than good Radio-Television training.

FREE 3 BIG RADIO TELEVISION BOOKS

I want you to have ALL the facts about my new 10-MONTH Radio-Television Training—without cost! Act now! Rush the coupon for my three big Radio-Television books: "How to Make Money in Radio-Television," PLUS my new illustrated Television Bulletin PLUS an actual sample Sprayberry Lesson—all FREE with my compliments. No obligation and no salesman will call on you. Send the coupon in an envelope or paste on back of post card. I will rush all three books at once!

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Dept. 25-H, 111 North Canal St., Chicago 6, Ill.

Mail Coupon Today!

NO OBLIGATION
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IF YOU ARE EXPERIENCED IN RADIO Men already in Radio who seek a short intensive 100% TELEVISION Training with FULL EQUIPMENT INCLUDED are invited to check and mail the coupon at the right.

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Please check Below About Your Experience

☐ Are You Experienced? ☐ No Experience

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metallized paper capacitors

PYRAMID Series M CAPACITORS use a specially-prepared metallized paper, providing all-important savings in size and weight. . . Pyramid now produces large quantities of these capacitors in a wide variety of cardboard or hermetically sealed metal containers.

Your letterhead inquiries are invited

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INTERPRETING Hot TV PATTERN

By
KEN KLEIDON
Belmont Radio Corp.

Part 1 of a three-part series. How the test pattern on the picture tube can be used to isolate the trouble. Once you have learned to interpret what you see, servicing is simplified.

WITH the rapid changes and new circuits being introduced in the growing television industry, the TV technician is compelled to develop new and modern servicing techniques to keep pace. A troubleshooting procedure, based on the picture tube as a source of information, has been developed by C. W. Hoshour, director of service, *Belmont Radio Corporation*, and presented in recent lectures to technicians throughout the country.

It is a known fact that a good radio technician can shoot trouble in a radio receiver by simply using his ears. He can translate into circuitry, what he hears and usually put his finger on the trouble. By the same token, a TV technician can use his eyes to ferret out service faults. The picture tube is an important and readily available piece of test equipment and it furnishes a great deal of servicing information. If the TV technician knows in what way the various circuits contribute to a normal television picture, he can, by viewing the face of the picture tube, determine what particular circuit is causing a certain trouble. The ability of a technician to interpret what he sees on the face of the picture tube will provide him with a quick, easy, and modern method of television troubleshooting.

The test patterns reproduced in this and the articles to follow are actual photographs of the picture tube of an operating television receiver. The various conditions were simulated in the receiver to give the desired results. Only a few were touched by the artist's brush as the desired conditions could not be set up at the time. The test pattern used is the *RCA* "Indian-Head" superimposed on a pattern consisting of 24 dots horizontally and 14 dots vertically obtained from a composite video and r.f. generator at *Belmont Radio*.

Fig. 1 is the average television picture that can be seen on any normally operating receiver in a local signal area. Obtaining a good television picture depends on the following factors; station transmission limitations, receiver design and adjustments, signal strength, and antenna installation. The station transmission curbs greatly limit the over-all quality of a television picture. Present FCC standards limit the system in bandwidth and resolution and provide a picture which is equivalent to 16 mm film. A 16 mm film has approximately 250,000 picture elements whereas the standard 35 mm movie film has approximately 1,000,000 elements. Thus picture quality is limited because of present transmission standards and "movie quality" should not be expected.

Receiver design and adjustments also play an important role in obtaining a good picture. A receiver should have a tuner with ample gain and a high signal-to-noise ratio, i.f.

Fig. 1. Normal picture. It is clear, steady, with proper contrast between black, white, and various shades of grey, is properly centered and focused, and has excellent definition.

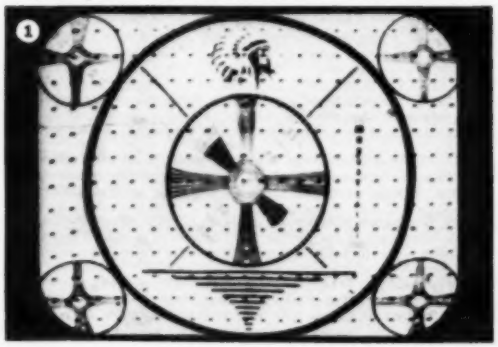
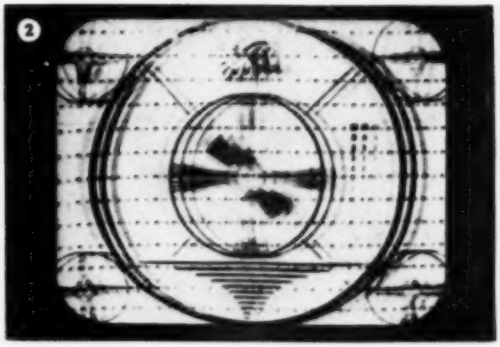
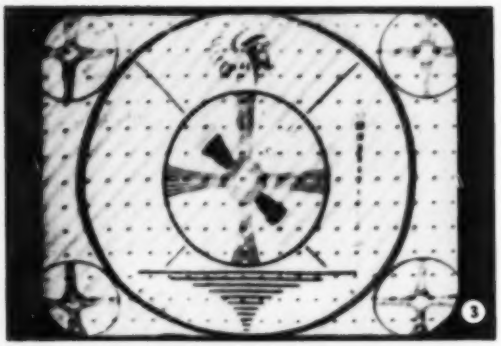
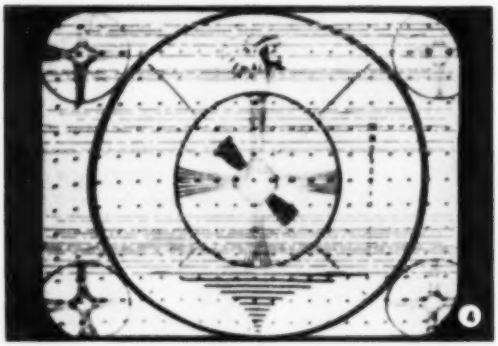
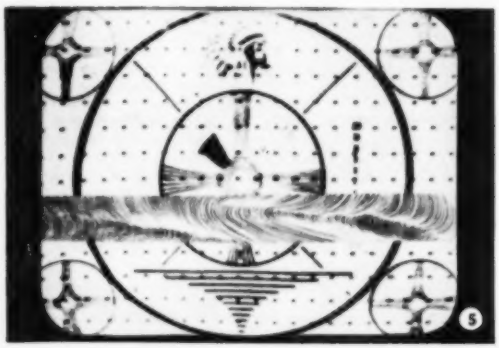


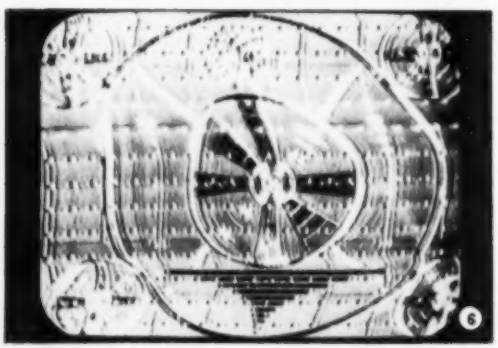
Fig. 2. An example of ghosts or multiple images. The image at the far left is the original unreflected signal while the various displaced images to the right are reflected pictures.











and video amplifiers of sufficient gain and bandpass to obtain all the reproducible frequencies, a good a.g.c. system to prevent overloading in strong signal areas and fading in weaker signal locations, and good sync circuits in order to avoid poor synchronization. Receiver adjustments to fill the screen and give reasonable linearity, r.f. and i.f. alignment, centering, focus, and proper contrast are also important and must be made in order to obtain a good picture.

Signal strength will depend mainly upon the distance from the TV station, station transmitting power, and the surrounding terrain. Buildings, mountains, or hills may reduce the signal strength and produce objectionable ghosts. As a general rule, picture quality will improve with increased signal strength.

Antenna installations will vary with the signal strength available. In low signal areas much more attention must be given to the installation. Such points as height, orientation, length and matching of transmission line, and gain of the antenna must be considered to obtain a good television picture.

There are four basic types of outside interference which are detrimental to a good picture. Their effect on the picture is easily discernible but in many cases the interference can be minimized or eliminated. Many articles have been written on these various types of interference, therefore, only the more important points will be covered in this series. These four types of interference are quite common but since they cause considerable trouble for the technician, they are worthy of consideration.

Ghosts or multiple images are transmitted signals which are reflected from buildings, mountains, or other objects in the vicinity and reach the antenna at different time intervals. The signal time delay causes displaced images, as shown in Fig. 2. Fig. 2 represents the original and three reflected signals. The image at the far left is the original unreflected signal. The sync has stabilized on the first ghost reflection and it has greater signal strength. Thus, it appears that there is one forward and two trailing ghosts.

There is no set or standard procedure for eliminating ghosts. There are many solutions that have proved successful in various locations. However, the same solution may not always produce the desired results. The trial and error method often proves to be the best procedure. In an area where ghosts are present, orienting or rotating the antenna may produce a stronger unreflected signal and decrease the strength of the objectionable signal causing the ghosts. In some cases, pointing the antenna toward the source of reflection rather than the station may produce favorable results. Other suggested remedies include installing a more directional type antenna, using separate channel antennas, installing an antenna rotor, matching the antenna to the receiver, connecting a shorted quarter-wave tuned stub, or eliminating standing waves by obtaining the correct transmission line length.

One other solution may be to relocate or move the antenna. In some cases, moving the antenna only a few feet completely eliminated all traces of ghosts. The distance and direction the antenna should be moved are usually best determined by trial and error. The distance the antenna should be moved can also be determined mathematically. This is accomplished by using the ratio of ghost displacement as related to picture width. The picture

Fig. 3. An example of r.f. interference. Narrow, evenly-spaced bars appear diagonally between a vertical or horizontal position. Bars may be wavy or bent and vary widely in number.

Fig. 4. Ignition interference causes sporadic black and white streaks in the horizontal direction. They move vertically and at random with no particular pattern discernible on the screen.

Fig. 5. Diathermy interference produces a herringbone pattern which tears part of the picture in a horizontal plane. This is generally synced vertically and may also move vertically.

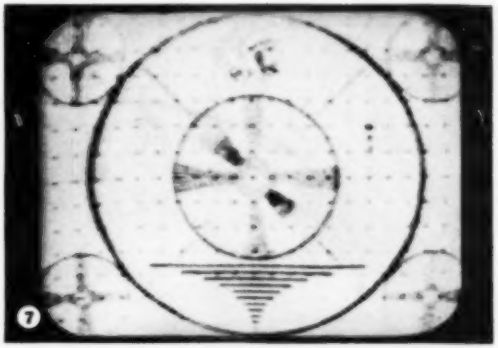
Fig. 6. Mistuning, faulty antenna installation in fringe areas, or overloading causes white following black portions of picture to appear as ghosts with poor over-all definition. May be accompanied by poor sync and horizontal pulling of raster.

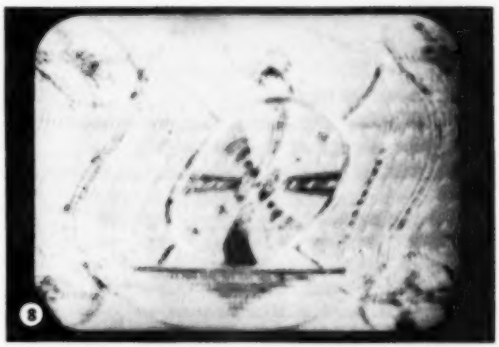
Fig. 7. Normal fringe reception characterized by lack of contrast accompanied by snow and, in some cases, susceptibility to r.f. interference. Good horizontal and vertical sync stability is difficult to obtain under such fringe area conditions.

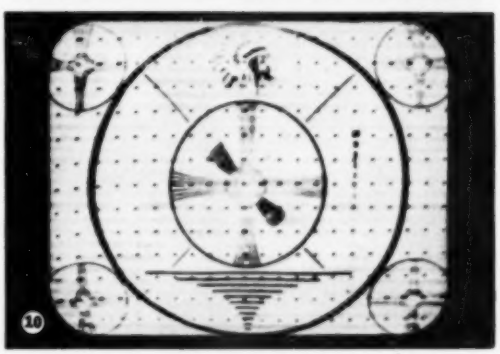
Fig. 8. Ghosts and weak signal conditions are apt to cause snow, poor contrast, poor sync stability, and horizontal displacement.

Fig. 9. An example of 60-cycle hum. The light and dark shading of the picture in the horizontal plane usually exists only when a picture signal or carrier is present at the r.f. input.

Fig. 10. Sound bars. Intermittent light and dark shadings of picture in horizontal plane may or may not move vertically.







width corresponds to approximately 9½ miles of the delayed distance traveled by the reflected signal. Displacement of the ghosts, illustrated in Fig. 2, as related to picture width shows an approximate delay of ¼ mile. Knowing the additional distance traveled may assist in determining the reflecting source.

A case of r.f. interference is usually caused by a strong signal whose frequency is higher than the station's received video carrier. The strong signal may be radiated and picked up from high powered radio equipment in the vicinity, local oscillator in a nearby receiver, or radio from ham equipment. The interfering signal beats with the video carrier thus producing a "difference" frequency falling within the video range. The higher the interfering signal is above the video carrier the narrower and more numerous the diagonal lines. An interfering signal approximately 3 megacycles above the video carrier is illustrated in Fig. 3. This type of interference may not affect every station and may vary from station to station in different locations. One point of interest to remember concerning r.f. interference is that the amount of picture interference is governed by both the signal strength of the station and the strength of the interfering signal. The stronger the station signal the less will be the effect of the interfering signal.

Such r.f. interference may also be caused by radiation from video detectors (similar to heterodyne "tweet" in broadcast receivers) and sound discriminators or r.f. high voltage power supplies in older type receivers. Keeping the antenna transmission line away from these portions of the receiver may help reduce the interference. In apartment buildings where local oscillator radiation is offending, the use of a master antenna system completely eliminates this problem. Not much can be done to eliminate r.f. interference unless corrective measures are taken at the source of interference. Means of reducing or eliminating this type of interference include the installation of a more directional, higher gain antenna, the use of wave traps and tuned stubs, or shielding the transmission line to reduce pick-up.

Ignition type interference, characterized by black or white streaks running across the picture (Fig. 4), is generally due to breaking contact-type electrical equipment such as the ignition systems of trucks and cars, cash registers, electric razors, vacuum cleaners, or adding machines. This interference can be picked up by the antenna or transmission line or can come in through the power line. A power line filter installed between the receiver and wall outlet will usually eliminate the power line as a source of interference. Other possible remedies are to relocate the antenna so that it is as far away from street traffic as possible, twist the transmission line approximately one turn per foot, or install shielded transmission line. Another condition which simulates ignition interference may be due to corona or arcing in the high voltage supply.

Diathermy interference, Fig. 5, is generally caused by radiation from x-ray equipment, commercial r.f. heating units, ultraviolet and fluorescent lights, brush motors, and other 60-cycle operated equipment. This type of interference is best reduced or eliminated by installing some type of corrective measures at the source. Since this is not always possible, other methods, such as installing a booster, high pass filters, or tunable stubs must be tried. The last mentioned suggestion has proved successful in various instances.

(*Continued on page* 150)

THE JUNCTION TRANSISTOR

Comparative size of the new junction transistor and a standard miniature type 6AK5, which is ¾" in dia.

Details on Bell Laboratories' newly-developed unit and a discussion of some potential uses.

By
H. S. RENNE
Technical Editor
RADIO & TELEVISION NEWS

THERE was a tremendous amount of excitement among electronic engineers when the first point-contact transistor was announced by *Bell Telephone Laboratories* some four years ago. This initial enthusiasm, however, was soon replaced by a great deal of hard work at the laboratories where efforts were made to iron out the "bugs" existing in the original design, and to ready the device for mass production. These goals have now been reached and reliable, uniform point-contact transistors are in limited production.

The original interest in transistors was given a new stimulus last July with the announcement of the *junction transistor*. Based on theoretical work at *Bell Laboratories* by Dr. William Shockley, this new device possessed qualities which seemed to indicate that in many respects it would prove to be superior to the point-contact type of transistor. Intensive research and development work is now in progress all over the country to determine its limitations and capabilities and to prepare it for mass production.

Transistors are constructed of a metal called *germanium*, which is classed as a semi-conductor. Conduction of electricity through germanium can take place either by a flow of electrons or by a flow of so-called "holes" which are, in effect, an absence of electrons. The result is similar to what would occur if an electron were replaced by a positive charge. The type of conduction is determined by very slight amounts of impurities in the germanium. If these impurities are such that conduction takes place by means of electrons, the germanium is of the "N" type. If conduction is by means of "holes," the germanium is known as the "P" type.

The basic construction of the junction transistor is shown in Fig. 1. It consists essentially of a very thin wafer of "P" type germanium cut from a single crystal and placed between two tiny bars of "N" type germanium, also cut from a single crystal. Because of this construction, the junction transistor is often referred to as the "NPN" transistor.

This new device has many characteristics which entitle it to be called the first serious rival to the vacuum tube. Its amplifying properties are in many respects superior to conventional tubes, and it is far more rugged with respect to shock and vibration than any known tube. It is much smaller (about half the size of a pea), and has an expected service life greatly exceeding that of conventional tubes.

Fig. 1. Basic construction of the junction transistor. Two types of germanium are used.

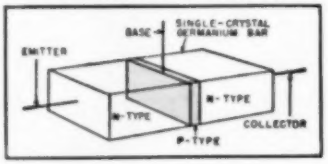


Fig. 3 shows the form of presentation which has been adopted for the junction transistor. The base is the center or "P" type section of germanium; the collector and emitter are the "N" type sections.

Power amplifications as high as 50 db (100,000 times) have been achieved with specific units, and it is reasonable to assume that this figure can be approached or even exceeded in production units. The actual power output rating of the transistor itself is rather small, depending primarily on the cross-sectional area of the germanium at the junction. Most of the experimental units use a germanium rod about a sixty-fourth of an inch in diameter, and have an output rating on the order of 50 milliwatts, heat dissipation within the unit being the limiting factor. One transistor has been assembled with a cross-sectional area of a square centimeter which has a rating of two watts, and still higher-powered units are possible.

A variety of input and output impedances may be achieved by connecting the transistor in different ways. Fig. 2 shows the three possible connections, together with a corresponding practical circuit for each.

The arrangement in Fig. 2A is called the grounded-base circuit, characterized by a low input impedance and a high output impedance. Typical values would be from about 50 to 250 ohms for the former, and from 1.5 to 13.5 megohms for the latter. These values depend to quite a large extent on the construction of the transistor, as well as the amount and kinds of impurities present in the germanium. Power gains of 40 to 50 db can readily be achieved with this arrangement when impedances are matched, and appreciable gains can be obtained with a load resistance of only a few thousand ohms. One advantage of the latter arrangement is that the gain is almost completely independent of those transistor properties which vary from unit to unit. When amplifier stages of this type are cascaded, a matching transformer should be used.

The second type of connection, illus-

trated in Fig. 2B, is known as the grounded-emitter circuit. This is the most desirable circuit for many applications. Input impedance is higher and output impedance much lower than for the grounded-base arrangement, typical values being 250 to 1500 ohms for the input impedance, and 250,000 ohms to 1.5 megohms for the output impedance. Maximum available gain is over 50 db. In the practical circuit of Fig. 2B, the base will float at a certain potential. If a different potential is desired, various arrangements for biasing may be used. A two-stage amplifier utilizing this circuit and having a power gain of about 90 db is shown in Fig. 4. This amplifier is pictured at the right of Fig. 5.

The power gain available from the grounded-collector stage, shown in Fig. 2C, is rather low, about 15 to 20 db, but the circuit has certain other advantages which make it desirable. Input impedance is high although varying widely with the load resistance. Output impedance likewise depends upon input loading, but in general is quite low. Thus, this circuit arrangement takes on the characteristics of a cathode follower, and if the source impedance is on the order of a few thousand ohms, the output impedance may be 25 ohms or less. Audio enthusiasts would undoubtedly like to use this device to drive a voice coil direct, without using an output transformer!

The junction transistor is especially suited for use at very low power levels. Its efficiency is exceptionally high, closely approaching the theoretical maximum of 50% for Class A and 100% for Class C amplification. Thus, the input battery power required can be extremely small. For example, an audio oscillator (shown at left, Fig. 5) has been built which operates satisfactorily with an input power of only 0.08 *micro*watt, consisting of 50 millivolts at 1.5 *micro*amperes! To demonstrate the small power required, Mr. R. L. Wallace, of *Bell Laboratories*, powered this oscillator with the output of a photovoltaic cell exposed to room illumination. In another experiment, he formed a battery by wrapping a dime in a piece of paper which he had previously moistened by chewing on it. The moist paper became one electrode of the battery, and the dime the other. In both cases, the output was sufficient to be audible from an ordinary headphone.

Mr. Wallace also performed some interesting calculations to show that this device could really be called a "flea-power" device. Assuming a dog flea weighing one milligram and jumping to a height of 50 centimeters, both of which are reasonable figures, he calculated that the flea, in making one such jump every minute, would use approximately the same amount of energy as the minimum required to keep the oscillator functioning! It is logical to assume, therefore, that satisfactory amplifiers can be built which would operate on comparably small amounts of input power.

It should not be supposed from the previous discussion that this transistor is a cure-all for everything. There are disadvantages which may or may not be overcome in future development work. One is the problem of frequency response. Maximum gain of the junction transistor is attained at frequencies on the order of a few kilocycles, with the gain falling off rapidly as the frequency increases. (Usable gains up to one megacycle and more have been realized, however.) One factor affecting frequency response is the transit time of the electrons and "holes" through the "P" layer. Making this layer thinner should increase the frequency response, but it would also increase the capacity between the two "N" electrodes. A thickness of about a thousandth of an inch has been used for this "P" layer.

Another problem is that of the mass production of these items. The amount of impurities in the germanium must be controlled very carefully, as variations of as little as one part in one hundred million can change the properties of the transistor. Also, there is the mechanical problem of fastening leads to such small pieces of germanium. How this is done on present samples has not been revealed. The units must be made to have uniform characteristics in production, so that a transistor in a piece of equipment may be replaced by another transistor without re-engineering the whole circuit. Samples which have been tested have been found to be very temperature-sensitive, although operation is completely satisfactory over normal temperature ranges.

These problems are gradually being overcome and it is expected that production samples on a limited basis will be available not too many months hence.

Here is a device which most certainly will give the vacuum tube a run for its money—if not completely replace it—in the majority of applications. It has

(*Continued on page* 166)

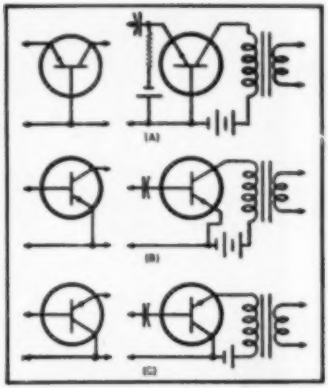


Fig. 2. How the input and output impedances may be varied by connecting the junction transistor different ways. In each case, the connection is shown along with a corresponding practical circuit. (A) Grounded-base circuit. (B) Grounded-emitter circuit. (C) Grounded-collector hookup. See article for a complete description of their possible applications.

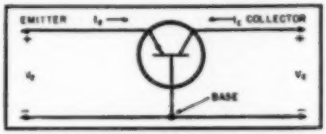


Fig. 3. Symbol which has been adopted to designate the junction transistor.

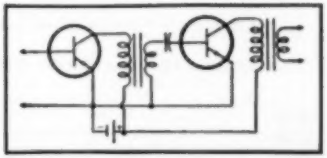
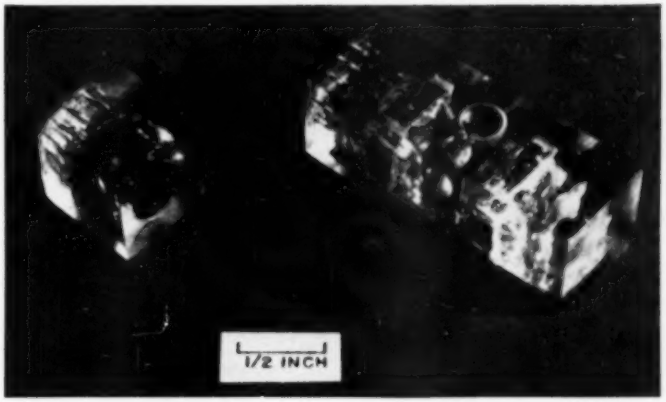


Fig. 4. A grounded-emitter type circuit used as a two-stage amplifier which has a power gain of approximately 90 db.

Fig. 5. (Left) Audio oscillator which operates with an input power of .08 microwatt and (Right) a two-stage audio amplifier which was built using the circuit of Fig. 4.



MAGNETIC TAPE DUPLICATION

Partial view of bank of five tape duplicator machines. Two vu meters, mounted at back of each unit, monitor the outputs of dual-track twin playback amplifiers. Toggle-type tension adjusting switches are left and right of meters.

By
LEON A. WORTMAN

Director of Adv. & Sales Promotion
Audio & Video Products Corporation

Here is one approach to the duplication of high quality pre-recorded music. Information on other companies' methods will be given in later issues.

BY THEIR very nature, original tape recordings cannot be processed to produce a large quantity of duplicates in the same way that original disc recordings are handled. That is, one cannot make a mold or matrix from a length of magnetic tape for pressing purposes. Thus, in modern recording and mass duplication techniques, the advent of magnetic tape recording and its popular acceptance by professional and non-professional users has brought about a unique problem: how to make a mass number of copies of an original tape recording that are faithful in reproduction, yet can be accomplished rapidly and economically.

The *Minnesota Mining & Manufacturing Company* has been coping with the problems of mass duplication of tapes for many years. To my knowledge, they have evolved two distinct techniques. One is a "printing" process in which a virgin tape and the original tape are rolled in close contact together at a high speed through a magnetic field. This usually results in a modified duplication of the original, not entirely a facsimile, and not completely satisfactory from the distortion standpoint. The other technique is one of re-recording from the original tape to a multiple number of reels driven from the same capstan (a long shaft) and passing across individual recording heads. This has proved to be more satisfactory than the first. However, for some reasons with which I am not familiar, the results were still not entirely satisfactory facsimile copies of the original tape.

This leaves private industry very much on its own with respect to developing completely satisfactory techniques of tape duplication. Since the majority of the customers for a tape copying service are professional broadcasters and true high fidelity enthusiasts, nothing less than an exact facsimile of the original sound is acceptable. Thus, any organization which becomes involved in the manufacture of a catalogue of "tape records," at present, finds itself completely on its own, without a backlog of experience from which to draw. That was the position of *A-V Tape Libraries, Inc.* a year ago when it was created for the purpose of manufacturing and merchandising a catalogue of music, pre-recorded on magnetic tape.

They had the same problem to surmount as do the others: how to do professional quality duplication work? One practical solution to the problem was supplied by the engineering departments of *Ampex* and *Audio & Video Products Corporation.*

Ampex had recently developed a new recorder which would faithfully record and play back signals as high as 100,000 cycles-per-second. This is the special-purpose equipment which is now used extensively by military and scientific research specialists in telemetry and data recording. This meant that, operating at a multiple speed, the entire audio spectrum could be rapidly re-recorded from one tape to the other without attenuating either the bass or treble ends, and done rapidly enough to maintain the factor of economy. As a matter of fact, aside from the cost of the original equipment and virgin magnetic tape stock, the entire cost of duplication is labor alone, since no "processing" is involved.

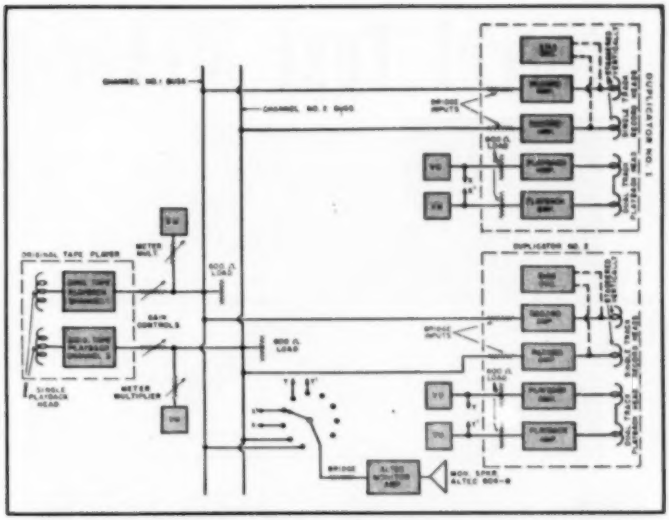
Referring to the block diagram, Fig. 1, an *Ampex* tape transport mechanism is used for the playing of the original tape. However, the standard magnetic head housing was modified for this installation. It contains no erase or record heads, but it does contain two separate playback heads. These two heads are staggered vertically so that both tracks of a dual-track tape can be played back simultaneously. The electronics chassis contains dual playback amplifiers, one for each track. Of course it does not contain an erase-bias oscillator or any record circuitry. When it is necessary to erase tape, a *Cinema* Degausser (tank erase) Type 9205 is employed.

The output of each playback chan-

nel terminates at line level in the audio rack which can be seen in the photographs. Separate gain controls are provided for each playback channel to insure a matched balance between the two levels. Across the output terminals of these gain controls are meter multipliers and vu meters for gain-setting. The outputs of these playback gain controls terminate in Channel Busses #1 and #2, across which are bridge-multipled the inputs to the duplicators.

At the moment, there are five master tape duplicators. Like the original tape player, modified tape transport mechanisms are used. No erase head is provided, but bias current is generated for the two separate record heads which are staggered vertically, in the same way that the heads are staggered for simultaneous dual-track playback in the master machine. The head housing also contains a dual-track playback head for monitoring purposes. The electronics chassis contains dual record amplifiers which are fed independently to each of the two staggered heads. Dual playback head amplifiers are also contained on the electronics chassis. Thus, dual-track tapes are rapidly produced by simultaneously recording both tracks, resulting in an important reduction in labor-time costs on this score by as much as one-half.

The vu meter panels are mounted above and to the rear of each of the five tape duplicators. Connected to the outputs of the duplicator playback amplifiers, they permit continuous visual monitoring of the operation of the individual duplicator channels. An audio power amplifier, mounted in the rack,



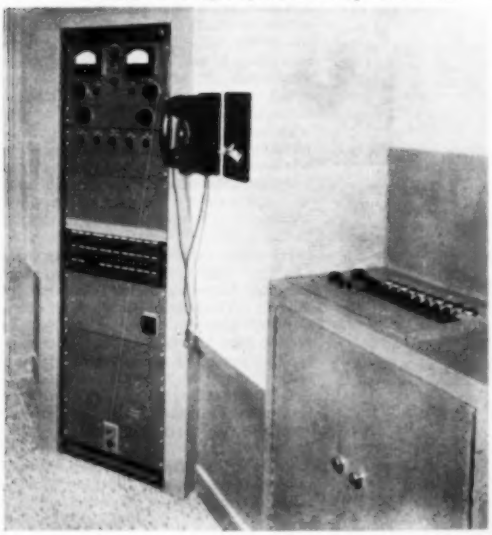
Block diagram of the Audio & Video tape duplicating set-up used for the mass duplication of the A-V Tape Libraries' music catalogue. Only two of the machines are shown.

is connected for bridging and, through a rotary selector-switch, can be placed across either of the two channel busses or across any of the ten duplicator playback channels. Because of the accelerated tape speeds involved, the audio monitor functions as an indicator of the existence or non-existence of signal and as a check on over-all level changes. An experienced operator can actually detect changes in frequency response in addition to level changes. By carefully auditioning the original tape at the correct speed and on standard *Ampex* Model 200 and 300 equipment, the quality of the original recording is predetermined. Frequent spot-checking by actually playing every fifth duplicated tape that each machine produces permits close quality control of the finished product.

An additional operating feature is the specially installed "tension selec-

(*Continued on page* 134)

Audio rack and remote control panel. The two vu meters in the audio rack monitor the outputs of the dual-track playback channels of the original tape player. Patching facilities are provided. The key switches of the remote control panel enable the single or multiple operation of any or all units.



Another view of duplicating machine bank. The original tape player machine is on the left. Original tapes are usually recorded at 15 or 30 inches-per-second. However, industrial or sales training tapes are frequently supplied at 3¾ or 7½ inch speeds. These are also handled by this particular set-up.

Novel Test Meter

By
PHIL WEISS
and
ED. CLARK

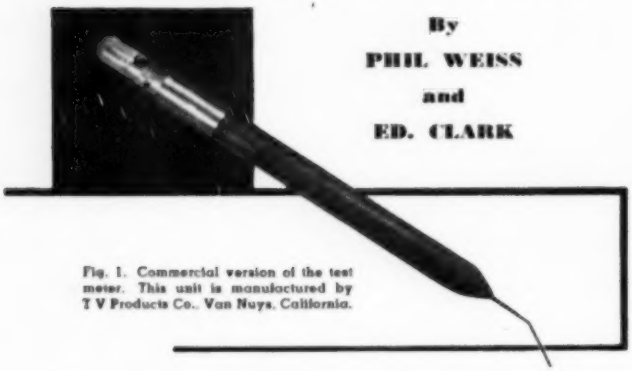


Fig. 1. Commercial version of the test meter. This unit is manufactured by T V Products Co., Van Nuys, California.

Details on a simple instrument which will permit d.c. voltage checks to be made on home TV calls.

THE meter that a technician uses to check a TV set in the customer's home is quite different from the one he would use in his shop. In a shop instrument the important characteristics are: accuracy, stability, high impedance, and good frequency response. In a field instrument the most important characteristics are: ruggedness, convenience, compact size, and light weight.

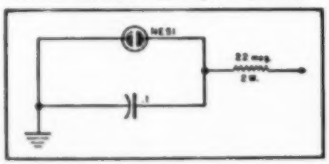
On a house service call the meter is seldom used except to check the d.c. voltage at a few power points, and at the plate and screen of a few tubes. Here the accuracy of the meter is quite unimportant when working on an unfamiliar chassis, with no circuit diagram, and only a general idea of what the correct voltages should be. For this type of work the technician requires a simple, rugged meter small enough to fit in the tool box. If greater accuracy is required, he may also keep a v.t.v.m. out in the car, to be used on rare occasions. For years the author carried the common volt-ohm-milliameter in his tool box. The standard one-mil movement was too insensitive for many applications, particularly for use with a standard high voltage probe. The special high voltage probe built for this meter was too bulky and loaded the circuit excessively (1 mil at 20,000 volts is 20 watts!). The meter leads were always tangled, with broken clips and the insulation burned from brushing against hot tubes and drawing high voltage arcs.

The instrument was too big to fit inside most TV cabinets, where it was too dark to read it anyway, so it was usually set on top of the cabinet, a hazardous location at best. As a result of its many falls from cabinets the glass was broken and the plastic case cracked. The pointer was banged out of shape, the switch was erratic, and the knob was always falling off. The meter was costly to replace, and too big and heavy to carry around in a crowded tool box.

The "flash-meter" shown in Fig. 1 is the size of a fountain pen. The parts cost 50 cents. It uses no lead wires. The tip is applied to the point of measurement and the ground-return is through the user's body. The body resistance is negligible compared to the high impedance of the meter. One finger is held against the metal band on the instrument, and another finger, of either hand, touches the chassis. The neon glow lamp indicates the d.c. voltage by flashing at the rate of one flash per second per hundred volts. With a little practice, voltages can be read within 25%, or about as close as on the meter with the old bent pointer, through the cracked glass in a dark room.

The current flow is too slight to be noticed even by the most squeamish, but a ground wire may be used if desired. The flash-meter is especially handy in sets where the chassis is not grounded. The ground finger is placed on the chassis as if it were ground, since the leakage resistance to the chassis is usually much less than that of the instrument.

Fig. 2. Circuit diagram of test unit. The resistor should be as large as possible.



The circuit is shown in Fig. 2. The resistor is the highest standard value obtainable, and is safe to use up to 3000 volts. It provides a higher input impedance than most v.t.v.m.'s. The condenser is used to store up enough energy to cause a visible flash, and is chosen to give a convenient rate of flash. Higher values of resistance or capacity would result in a proportionally slower rate. Flashes up to 10 or 15 per second can be evaluated by waving the neon lamp back and forth slightly. The lamp itself is an NE51, and is easily replaceable if broken.

Unfortunately, the neon lamp will not flash below 75 volts. Lower voltages can be measured indirectly by placing the ground return finger at some convenient point at about 150 volts and measuring down from there. Again for the squeamish, a ground wire may be used. Another less convenient, but safer, method to measure below 75 volts, is to hold a tiny 67½ volt battery in series with the ground finger, thus extending the range of the flash-meter down to 7½ volts. The drain on the battery is very small.

Voltages around 10,000 volts can be measured with the aid of a standard high voltage probe. With a 560 megohm probe, the lamp flashes four times per second at 10,000 volts. A cheap high voltage probe can be made by assembling four 22 megohm resistors in series inside a bakelite tube. This gives a flash rate of 20 per second at 10,000 volts. If desired, the condenser can be reduced in value five times, which makes the instrument more useful at high voltages, but rather tedious to use at low voltage, since it would flash only once every 5 seconds at 100 volts. This makes the instrument quite accurate, if a watch is used to time the flashes, but of course it is not intended to replace the v.t.v.m.

To sum up the advantages and disadvantages of the flash-meter as compared with any other device which can fit in the tool box: The flash-meter measures 6"x½"x½" and weighs just 2 ounces. It requires no leads and needs no switching. The impedance is 22 megohms and the unit may be used with a high-voltage probe. It is practically unbreakable and is almost burn-out proof. Accuracy of 25 per-cent is possible with this gadget and the unit will measure d.c. voltages from 75 to 1000 volts. It costs approximately 50c for parts.

By contrast, a 1 ma. meter measures 6"x3"x3" and weighs approximately 20 ounces. Both leads and switching are needed. The impedance is 1000 ohms-per-volt and the meter is nearly useless at high voltages. It is a relatively fragile instrument but will measure both a.c. and d.c. volts from 0 to 1000 in addition to reading ohms and milliamperes. Accuracy is about 10 percent and the parts required cost about $13.50.

From this comparison it is easy to see that this handy little meter has many advantages in TV servicing.

—30—

A Single-Sideband TRANSMITTER ADAPTER

By
JOHN F. CLEMENS
W9ERN

Front view of the unit. The adapter produces one watt of single sideband output on either 75 or 20 meters when driven by a c.w. input signal in the 4 mc. band. Toggle switch permits operator to select either upper or lower sideband output.

Used between the low-cost exciter unit and the 150-watt r.f. amplifier described in the February and March issues, this adapter permits single-sideband phone transmission on two bands. A voice-operated relay circuit is also included.

A NEW horizon in amateur radio communication is opening with the advent of practical single-sideband transmission. This type of radio phone has been used for years by commercial stations and the theoretical nature of the system has intrigued engineers with its terrific possibilities in savings of both radio spectrum and power. Only within the past few years have amateurs demonstrated that single-sideband communication is practical for the average amateur and many experimentally-minded hams are enjoying its many benefits on the air today. Anyone who has never heard this type of phone should listen near the high frequency end of the 75 meter band any evening. Of course, the uninitiated will be somewhat at a loss to understand the voices they hear, but a little experimenting with the receiver adjustment will reveal the secret of tuning in the signal. Briefly, the receiver is used in about the same way one would use it to receive a c.w. signal: a.v.c. off, b.f.o. on, audio gain full on, and r.f. gain reduced. The problem then is just a matter of tuning the receiver to the frequency where the b.f.o. would zero-beat the carrier of the transmitting station. Of course, the fact that the transmitting station is not radiating a carrier is somewhat of a complication, but slow and careful tuning will quickly make the voice understandable and very fine tuning will produce excellent quality. It is impossible to distinguish between single-sideband and conventional AM with a properly adjusted receiver, except that the single-sideband station will show little or no selective fading, and will usually be readable through considerably more interference since the receiver may be adjusted for greater selectivity without impairing reception.

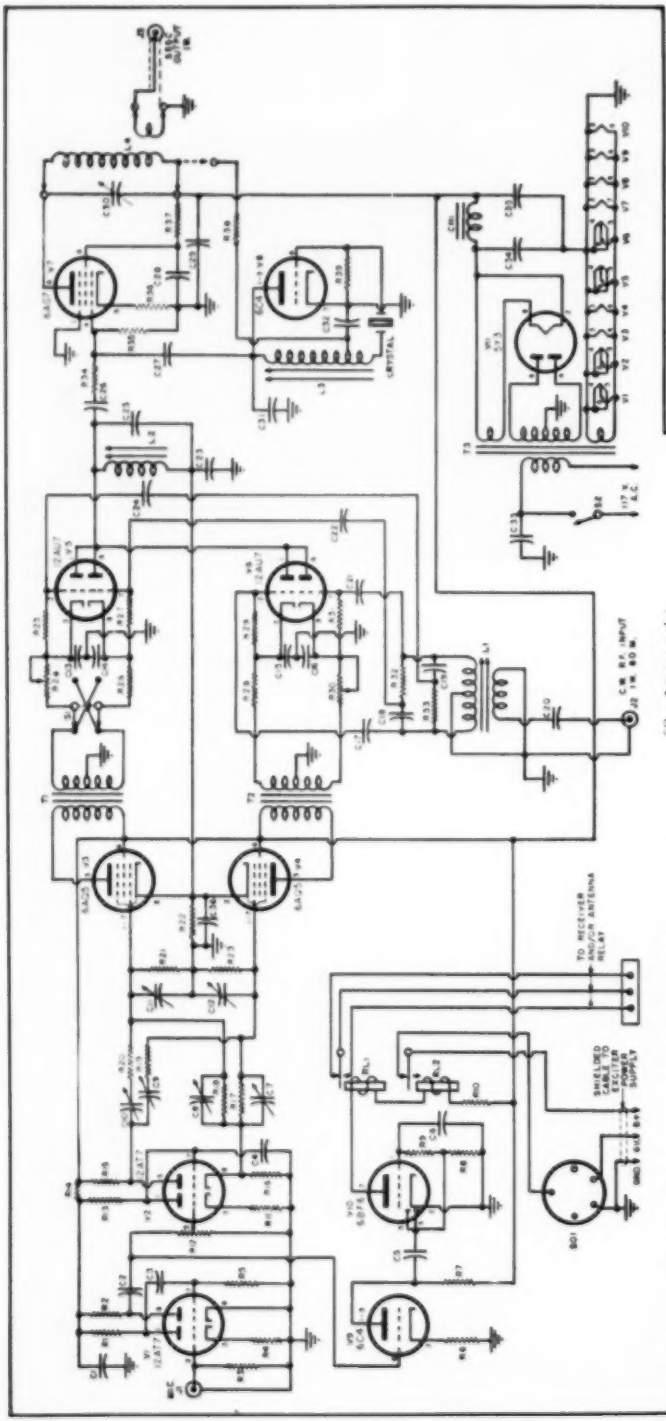
Two methods of single-sideband generation are in use among amateurs today. Both methods have some points in common. Of course, the received signal is the same irrespective of the system used to produce it and the requirements in the transmitter stages which amplify the signal to the desired power level are also the same. The two systems are called the "filter" system and the "phasing" system.

It is well known that in an amplitude modulated signal, three component waves make up the output signal which is transmitted to the receiver. These components are the carrier, which remains unchanged in frequency or amplitude during modulation, and the two sidebands. The frequency of the sidebands is determined by the modulation frequency, one being the sum of the carrier and modulation frequency, and the other being the difference between the carrier and the modulation frequency. The amplitude of the sidebands varies from zero, when there is no modulation, up to one-half the carrier amplitude at 100% modulation. Since these component waves are distinct, it is possible to transmit either of the sidebands, or both of them, without transmitting the carrier. In the filter method of generating the single-sideband signal, the modulated signal is merely passed through a very selective filter which will pass only the range of frequencies which the desired sideband will have with modulating frequencies over the voice range. This requires a filter about 3 kc. wide with very great attenuation at the frequencies of the carrier and the unwanted sideband.

The phasing system makes use of other principles, namely, balancing out unwanted components by generating, simultaneously, components equal in amplitude but of opposite phase. All these signals are combined in a common tank circuit, where the unwanted components combine in opposite phase and hence add up to zero, while the desired sideband components add in-phase to produce the output signal. The necessary phase relationships for this balancing procedure are obtained automatically in the following arrangement:

Two separate transmitters are driven from the same source of r.f., at the carrier frequency. The r.f. driving power for one of these transmitters is passed through a network which shifts the phase of the voltage by 90 degrees, while the other transmitter receives its driving voltage directly from the r.f. source. Therefore, the two transmitters are being driven by voltages 90 degrees apart in phase.

An audio signal is used to modulate each transmitter independently by conventional circuits. Audio voltages for the two transmitters are again derived from the same source, but the audio signal is passed through a network of resistors and condensers which has two pairs of output terminals, and due to



R_1, R_2—470,000 ohm, ½ w., res.
R_3—1 megohm, ½ w., res.
R_4, R_{12}—2200 ohm, ½ w., res.
R_5—2.7 megohm, ½ w., res.
R_6, R_{11}, R_{13}—47,000 ohm, ½ w., res.
R_7—10 megohm, ½ w., res.
R_8—100,000 ohm, ½ w., res.
R_9—5600 ohm, 2 w., res.
R_{10}—2700 ohm, ½ w., res.
R_{14}—1 megohm volume control
R_{15}—2.2 megohm, ½ w., res.
R_{16}—120,000 ohm, ½ w., res.
R_{17}—560,000 ohm, ½ w., res.
R_{18}—400 ohm, 10 w., wirewound res.
R_{19}—1000 ohm pot.
R_{20}, R_{21}, R_{22}—15,000 ohm, ½ w., res.
R_{23}—470 ohm, ½ w., res.
R_{24}—390 ohm, ½ w., res.
R_{25}—1.2 megohm, ½ w., res.
R_{26}, R_{27}—27,000 ohm, ½ w., res.
R_{28}—100 ohm, ½ w., res.
R_{29}—10,000 ohm, 1 w., res.
C_1—8 μfd., 450 v., elec. cond.
C_2, C_3, C_4, C_5, C_6—1000 μμfd. ceramic cond.
$C_7, C_{11}, C_{16}, C_{17}, C_{20}, C_{21}, C_{24}$—100 μμfd. ceramic cond.
C_8, C_{12}—5-25 μμfd. padder cond.
C_9—407 μμfd. padder cond.
C_{10}—525 μμfd. padder cond.
C_{13}—2420 μμfd. padder cond.
C_{14}—806 μμfd. padder cond.
C_{15}—176 μμfd. padder cond.
C_{18}—250 μμfd. ceramic cond.
C_{19}, C_{23}—1000 μμfd. ceramic cond.
C_{22}—10 μμfd. ceramic cond.
C_{25}—100 μμfd. air cond.
C_{26}, C_{27}—20 μfd., 450 v., elec. cond.
C_{28}—25 μfd., 50 v., elec. cond.
T_1, T_2—Mod. trans. (Merit A-3008 or equiv. See text)
T_3—Power trans., 350-0-350 v. c.t. @ 120 ma.; 5 v., 3 a.; 6.3 v., 3 amps.
RL_1, RL_2—1000 ohm sensitive relay, 10 ma. d.c. operating current
CH—10 h., 120 ma. filter choke
J, J—Coax receptacle
S—D.p.d.t. sw.
S_2—S.p.s.t. toggle sw.
SO—5-prong socket
Xtal—See text
L_1—Pri. 23 t., #30 Formvar on ⅜" form with slug; sec. 106 t., #30 Formvar close-wound over primary (Cambridge Thermionic Type LS-3 form)
L_2—45 t., #30 wire on ⅜" form with slug (Cambridge Thermionic Type LS-3 form)
L_3—36 inches of #30 wire tapped 12 inches from std end, wound on ⅜" form with slug
L_4—Grid: 13 t., #22 wire on 1" Millen form with 3 t. link
20 m.—11 t., #18 wire on 1" Millen form with 2 t. link and jumper
V_1, V_2—12AT7 tube
V_3, V_4—6AQ5 tube
V_5, V_6—12AU7 tube
V_7—6AG7 tube
V_8, V_9—6C4 tube
V_{10}—6BF6 tube
V_{11}—5Y3 tube
*The Cambridge Type LS-3 forms are available from Allied Radio Corporation, 833 West Jackson Boulevard, Chicago 7, Illinois, or from your local parts distributor.

Schematic diagram of the single-sideband transmitter adapter. This unit is designed to be used with the low-cost exciter unit and the 150-watt universal r.f. amplifier previously described by author.

the special design of this network, the output voltage at one pair of terminals always lags the output voltage across the other pair of terminals by one quarter of an audio cycle, or 90 degrees. When the output of the two separate transmitters is combined by connecting them to a common tank circuit, one of the sidebands is balanced out while the other is reinforced. Meanwhile, the carrier output of each transmitter has been prevented from reaching this tank circuit by resorting to an older and better-known circuit, the balanced modulator. Each modulated stage in each of the transmitters is a balanced modulator so that no car-

rier output appears in the individual transmitter outputs or the combined output of the two. This, in brief, is the mechanism of the phasing method of generating single-sideband signals. Reference to the bibliography will explain this system in greater detail.

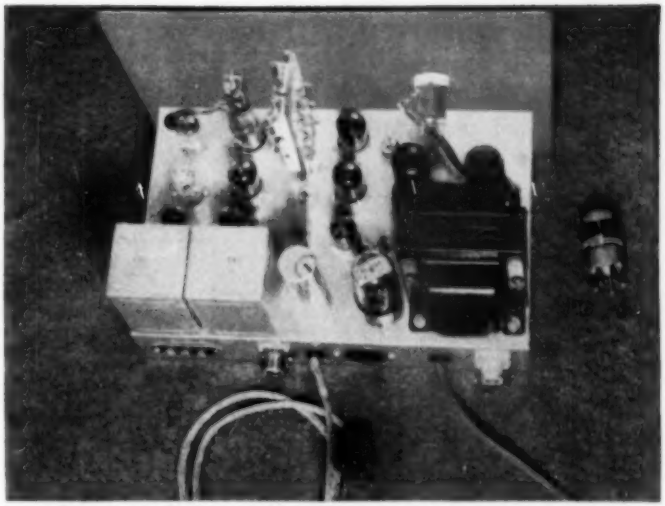
The principal benefits derived from single-sideband and suppressed carrier transmission are savings in power and frequency spectrum. It is a little difficult to give exact figures on the amount of power SSSC will save unless a specific example is given. For the purposes of this analysis it is desirable to speak, at the outset, of transmitter power output rather than input. Assume a conventional AM rig which has a rated output of 100 watts. This is the power in the carrier wave. At 100% modulation, each of the two sidebands will contribute 25 watts to the output circuit, so that the average power output at full modulation is 150 watts.

A single sideband will give equal coverage and "loudness" in the same receiver if its output is 50 watts. But since the spectrum of the transmitter is less than half as great as in the case of the AM transmitter, there is no reason why the receiver should not be used with greater selectivity. If the selectivity of the receiver is doubled, the signal-to-noise ratio will be improved to the point where a single-sideband transmitter with an output of only 25 watts will give the same signal-to-noise ratio as the original 100 watt AM rig. Essentially, then, a single-sideband transmitter rated at 25 watts will compete successfully with an AM transmitter having an output of 100 watts.

To obtain a carrier output of 100 watts will require an input to the AM transmitter of approximately 300 watts, assuming the use of grid bias or some similar form of efficiency modulation. (Plate modulation would give better efficiency in the r.f. power stage but additional power requirements in the audio power-generating stages would have to be charged against the over-all AM transmitter, resulting in about the same, or even slightly less, total transmitter efficiency.)

The linear amplifier in the single-sideband transmitter will, theoretically, be capable of an efficiency of 78%, but to be on the safe side we will assume that the actual efficiency obtained is only 50%. Therefore, an input of 50 watts to the single-sideband transmitter will be required.

It can be seen from this comparison that a much smaller single-sideband transmitter competes equally with a large AM transmitter with a practical ratio of about six-to-one. An additional benefit is derived from the fact that the linear amplifier in the single-sideband transmitter is operating at full input only with full modulation and it is possible that during periods of no modulation the power input may be close to zero. In the AM transmitter the input with no modulation is still

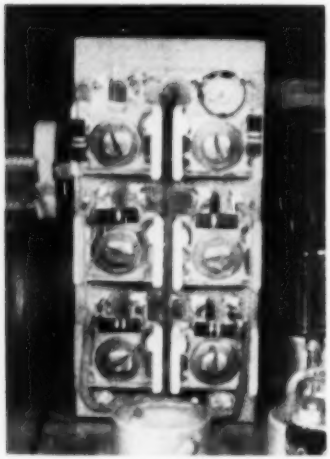


Rear view of adapter. The chassis measures 11x7x2 inches. The voice-operated relay contacts connect to the terminal strip for control of the external circuits.

300 watts. This means that the tube capacity in the AM transmitter must be very much greater than in the single-sideband transmitter. For instance, a single 807 should be limited to an input of about 45 watts in the type of AM rig we have used as an example, while the same tube is rated to deliver an *output* of 60 watts under the conditions of operation suitable for single-sideband suppressed carrier transmission.

The transmitter adapter pictured is designed to be inserted in series with the 50 ohm coax cable between the low-cost exciter and the 150-watt universal r.f. amplifier described by the author in the February and March, 1952 issues of this magazine, although it may be used with other equipment. It converts the one watt c.w. output of the exciter to a single-sideband signal having a peak power output of about one watt. Either upper or lower sideband is available with the flip of the toggle switch on the front panel. The phasing system is used. The unit is completely self-powered and auxiliary circuits are included to give voice-operated-relay control of the transmitter. The 80-meter signal of the v.f.o. is used to give v.f.o. operation over the entire phone band and by plugging in a 20-meter coil into the

Underchassis view. The general placement of parts may be seen in this photograph. The balancing controls and gain control are mounted on front panel of unit.



The audio phase shift network is composed of broadcast-type adjustable mica padders and ½ watt resistors, assembled on an insulating panel. A 1000 μμfd. silver mica condenser parallels the padder to obtain large capacity required of condenser C_m.

adapter, the same v.f.o. is used to cover the 20-meter phone band where the output is also one watt.

The simpler parts of the adapter circuit will be covered before analyzing the single-sideband generating system itself. First, a standard power supply delivers an output of 300 volts of well-filtered d.c. Hum can be ruinous to the quality of the SSSC transmitter in the low power stages, so adequate filter condensers should be used.

The 6C4 is used as a separate audio amplifier to drive the voice-operated relay circuit. This amplifier is connected to the output of the second microphone amplifier stage before the gain control so that settings of the gain control do not affect the relay operation. The 6C4 output is rectified by the diode plates of the 6BF6 and the resulting d.c. is applied as a bias voltage to the triode section. The relay windings are in the plate circuit of the triode section and the relays are held in by the plate current of the tube in the absence of audio signals. Since the coupling condenser, C_n, is charged through the low plate resistance of the 6C4, the bias appears on the grid of the 6BF6 almost instantly when an audio signal is introduced, causing the relays to be de-energized. R_n and C_n comprise an audio filter which prevents the audio voltage from reaching the 6BF6 grid, which would cause the relays to chatter, but the time constant of the combination is too short to cause any appreciable lag in actuating the relays. The bias voltage must bleed off the grid through R_n, and since it is of much higher resistance than the 6C4 plate resistance, there is a delay of a fraction of a second after cessation of the audio signal before the relays are re-energized. Thus, the relays close immediately when the operator starts talking and open a fraction of a second after he stops, but the lag is sufficient to hold the circuits closed during normal talking. By "closing" in this case, is meant, of course, closing the external circuits, *i.e.*, the v.f.o. plate supply and the antenna relay or receiver muting circuits which may be used.

The microphone input stage employs cathode bias to allow the use of a low-resistance dynamic mike. The second half of the 12AT7 uses contact potential bias to get more gain by avoiding cathode degeneration. There is plenty of audio gain for even low output mikes. The second 12AT7 is a direct-coupled phase inverter, with its balanced output direct coupled to the phase shift network. C_t is used to limit the high frequency response of the audio circuits to the range of frequencies over which the audio phase shift network is effective.

The audio phase shift network itself is built of standard value resistors (10% tolerance) and adjustable padder condensers. The padder condensers are of the same type but plates and mica may be pilfered from the low capacity units and added to the high capacity units. These condensers are best set to the desired value on a capacity bridge before being installed. The capacity values should be matched within about 5%. Once adjusted, the network needs no further attention. It should provide two outputs (at the grids of the two 6AQ5's) 90 degrees apart in phase and equal in amplitude, over a range of approximately 140 to 4000 cycles. The RC product of each element in the network is exactly equal to the value originally specified by Dome[1] but the values of the resistors have been increased ten times, while the capacities have all been reduced by a factor of ten. This results in a network of smaller components, while presenting load impedances to the associated tubes which are of conventional order. It should be noted that there is a d.c. path through the network from the 12AT7 cathode to each of the 6AQ5 grids, so that a portion of the cathode voltage appears at the 6AQ5 grids. This positive bias is compensated for by an unusually large value of cathode bias resistor (R_{28}) in the 6AQ5 stage so that the normal operating bias of the 6AQ5's is negative.

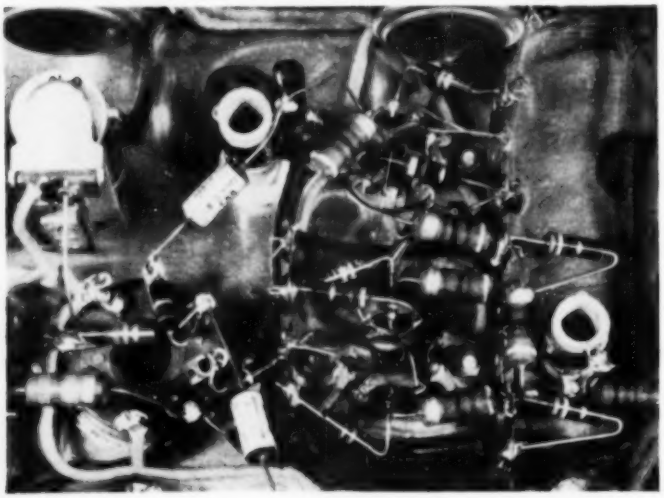
Approximately one watt of audio power is obtained from the secondary of each of the 6AQ5 output transformers, T_1 and T_2. Although the transformers shown are surplus SCR-522 modulation transformers run backwards, any small modulation transformer of about one-to-one ratio is satisfactory. Impedance matching considerations are not critical.

The radio frequency driving power is coupled into L_1 through a 50 ohm coax cable from the exciter. The primary effective inductance is resonant with C_m at the input frequency and the primary-to-secondary ratio of L_1 has been adjusted so that the resistive component presented to the input cable is 50 ohms. The input coax cable is therefore terminated in its characteristic impedance, the most efficient and desirable condition possible. The slug tuning L_1 is adjusted for maximum r.f. drive which corresponds to the matched condition. The turns ratio for L_1 was actually determined experimentally by means of bridge measurements on the input coax and if this coil is duplicated closely, a good impedance match is assured.

One of the balanced modulators receives its excitation voltage directly

(*Continued on page 152*)

Under chassis view of the r.f. circuits. The crystal oscillator and balanced modulator tank circuits both feed the 6AG7 grid. The r.f. phase shift condensers and resistors are assembled on the tie strip between the balanced modulator tubes and L_1.



WABD's TV TRANSMITTER

By SCOTT HELT
Research Dept., Allen B. Du Mont Laboratories, Inc.

Du Mont 5 kw. "Oak" transmitter installed at Station WABD, Empire State Bldg., New York.

WABD's new transmitter installation in the Empire State Building has many unique operating features.

THIS month's cover shows a portion of the new *Du Mont* WABD transmitter installation on the 82nd floor of the Empire State Building in New York City. The transmitting antenna is installed atop the 102nd floor of the building—a common steel tower being employed to support the transmitting antennas of WABD and several other metropolitan area television stations.

In the *Du Mont* transmitter installation the equipment is arranged in a "U" in order to bypass a large cross-section supporting column located in the center of the room. Despite this arrangement, it was necessary to locate the equipment in such a way that the operating engineer could have a clear view of all front panels and indicating instruments.

When the engineer is seated at the control console, thirteen racks of video and audio equipment, auxiliary to the transmitter, are installed to his right. The *Du Mont* 5 kilowatt (visual) and 2.5 kilowatt (aural) "Oak" type transmitter is installed to his left while the five transmitter cubicles, or cabinets, are mounted in the wall facing the thirteen racks of auxiliary equipment across the room. Thus the large cross-section column does not interfere with the station operation because of the carefully planned layout.

Metal duct piping and an exhaust system remove the warm air from the 5 kw. transmitter cubicles and equipment racks in order to keep the equipment at a safe operating temperature. The transmitter is air-cooled throughout so the warm air radiated by the tubes must be exhausted.

The transmitter console, behind which the operating engineer is seated, contains all of the controls and meters required for normal and convenient operation of the transmitter. The console has provision for placing the transmitter into or out of operation, and for checking its performance under regular operation—particularly with reference to the quality of the incoming and transmitted signals. In addition, equipment has been incorporated which will permit tracking down and eliminating operating faults and difficulties which may develop during the course of a transmission. All of the essential meters necessary to the operation of both the visual and aural portions of the transmitter are duplicated at the console so that the operator may read them without leaving his position.

A line waveform monitor at the console displays the video waveform on a small cathode-ray tube screen, the horizontal sweep being linear and precisely synchronized at half the line frequency of the video signal, *i.e.*, 7875 cycles-per-second. The horizontal scanning rate is, of course, 15,750 cycles-per-second under American television standards.

The frame waveform monitor, similar to the line waveform monitor, has a sweep frequency equal to half the field frequency of the video signal, or 30 cycles-per-second. The field rate in television is 60 cps.

Thus, the electronic information in the picture, at either the horizontal or vertical frequency, may be viewed by the operator on either one of the two small monitoring cathode-ray tube screens.

A larger picture monitor, which is capable of high resolution and is located at the center of the console panel, permits the operating engineer to continuously monitor the picture being transmitted.

Suitable gain and level controls and indicators are provided at the console for handling both the visual and the aural levels required for proper signal transmission.

Also visible in the cover photograph is the "Monochrome Scanner" which is housed in one of the auxiliary racks to the right of the console. This new unit replaces the monoscope camera chain which was formerly used to transmit the station's test pattern exclusively.

The *Du Mont* TA 150-B "Monochrome Scanner" not only provides a means for transmitting the station test pattern but may also be used to transmit regular 2" x 2" slides of the type used for advertising messages. These "spot" announcements in slide form may be inserted at any point in the program by merely pushing a button which controls the scanner. As many as 25 slides may be inserted in the magazine of the scanner at one time and the slides can be changed at the rate of one every .2 second, at the push of the button.

This scanner unit is actually a complete signal source for the television station and it is only necessary to provide horizontal and vertical drive and blanking from a standard sync generator to place this equipment in operation.

This equipment eliminates the necessity for "firing" up a whole camera chain just to transmit a test pattern or "spot" announcements on slides.

-30-

TV ANTENNA COUPLERS for Multi-Set Operation

By
WALTER H. BUCHSBAUM
Author, "Television Servicing"

Eliminate unnecessary antenna installations by using a single array to feed several TV sets.

THE problem of operating several TV receivers from a single antenna comes up frequently in TV service work. When a second TV receiver is sold it is quite a sales point to add that the present antenna will do the job for both sets. In the service shop itself it is important to have several antenna connections available and it is not always practical to clutter up the roof with four or five antennas, especially if the space is small and the antennas interfere with each other. In apartment houses the antenna situation is often the main reason why landlords discourage TV sets and sometimes prohibit roof antennas entirely. Thus, use of a single antenna for several TV receivers is a very desirable feature and knowing how to make such installations is bound to mean more money for the technician.

Many different devices are sold to the service trade for the purpose of permitting multiple installations, but not all of them will work in each particular instance. In many cases a simple home-made or inexpensive commercial unit will do a good job while in the other instances an elaborate, well engineered system may be needed.

Requirements

The three main requirements of any system of multiple TV installations are: enough signal, correct impedance match, and sufficient isolation to avoid oscillator radiation. *RTMA* standard measurements for receiver sensitivity use two indications; the number of microvolts input which will produce one volt of signal at the detector above noise, and the number of microvolts required to produce 20 volts peak-to-peak at the kinescope. A fairly sensitive receiver will require about 150 microvolts for 1 volt at the second detector and half that much for a 20 volt signal at the picture tube. If a 500 microvolt signal is supplied, any properly aligned receiver will give very adequate pictures. In fringe areas good reception is often obtained with 50 or 100 microvolts, but for our purposes let us assume that 500 microvolts is the minimum signal any good TV installation should supply. Most antennas within a 20 mile radius from a station will produce anywhere from 500,000 to 10,000 microvolts, much more than the minimum needs. To determine just how strong a signal a particular antenna is delivering it is best to use a calibrated field strength meter, but a rough indication may be obtained by measuring the a.g.c. bias of the TV set. If the bias for the i.f. tubes ranges from 4 to 6 volts, the signal is well over 10,000 microvolts in the average set. Readings and receiver sensitivities will vary, but whenever the bias reaches over 3 or 4 volts the signal is much stronger than needed. Since the signal must be divided up in multiple installations, the signal strength at the antenna is an important consideration and will determine just how elaborate and expensive the installation will be.

Assuming that the antenna picks up a clean signal of sufficient strength, the impedance matching of the antenna to the transmission line and of the line to the receiver are the next important steps. A mismatch at either end of the line can result in reflections or "standing waves" which means a loss in signal at the receiver plus the appearance of a reflection or "ghost" on the screen. In the average installation some mismatch usually exists, but it is so slight that it is not objectionable. For example, the antenna impedance at the feed points is rarely exactly 300 ohms, while the standard 300 ohm twin-lead does have that value as its characteristic impedance. The nominal 300 ohm input of most TV receivers can vary anywhere from 50 to 500 ohms and some laboratory measurements by the author show just such a variation in identical tuner models. To verify this, try grasping the twin-lead of any installation on a high-band station and slide your hand up and down the line. Usually some variation in contrast will be observed during this procedure. This, by the way, is the simplest check for reflections or standing waves on a twin-lead transmission line. The importance of impedance matching cannot be exaggerated, especially when more than one receiver is connected to a single antenna. We shall refer to this again when actual installations are described.

Interference from sources outside the antenna and its transmission line can be eliminated by using suitable filters as long as the interfering signal is not the same frequency as the incoming TV signal. In the latter instance a remedy may be quite complex or impossible. A particular type of such interference is radiation from another TV receiver. Assume that your set is tuned to Channel 5 and your neighbor's set to Channel 2. The picture carrier from Channel 5 has a frequency of 77.25 mc. and the local oscillator in your neighbor's set operates at approximately 80 mc. This 80 mc. signal will be received together with Channel 5 and produce a 2.75 mc. interference on your screen. This will appear as a weaving grid, superimposed on the picture from Channel 5. Varying the fine tuning control may have some effect on the grain of the interfering pattern, but the only sure way to eliminate it is to reduce the amount of radiated signal your antenna receives. There are many other combinations of TV channels that will show interference between two receivers due to oscillator radiation and a lot depends on the i.f. frequencies which determine the oscillator frequency. One solution to the problem is the adoption of 40 mc. i.f. amplifiers

which would place oscillator frequencies so far apart that there could be no interference within one TV band. Another solution lies in better shielding and decoupling in the design of TV tuners to minimize the radiated signal. Both of these solutions, however, are beyond the scope of the service technician and other means must be found to overcome this problem which becomes most acute when several receivers are connected to a common antenna.

Two Receivers On One Antenna

The simplest instance of multiple TV installations is the home having two receivers which are to be fed from a single antenna delivering a fairly strong signal. Assume that with a single receiver connected to the antenna, the weakest station will produce an a.g.c. bias of 4 volts. This corresponds to at least 10,000 microvolts at the transmission line terminals. Since we know that most receivers will give excellent pictures with 500 microvolts, considerable losses can be tolerated in coupling both TV sets to the single antenna.

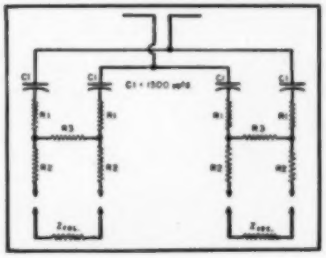
Fig. 1 shows the circuit for such an installation using resistor matching pads and isolating condensers. The purpose of C_1 is to avoid a.c. short circuits in case either or both receiver chassis are "hot" or grounded to the power line. The two H-type matching pads help to reduce oscillator radiation interference from one receiver to the other. It is true that they also result in a loss of signal, but we are only using these pads because more than enough signal is available. If each of these pads were designed so that $\frac{1}{10}$ of the input voltage appears at the output, the 10,000 microvolt signal would be reduced to 1000 microvolts for each receiver. This is quite sufficient for excellent pictures. The oscillator radiation from one set to the other, however, would be reduced not ten, but a hundred times. The first pad would reduce it ten times, and the second pad would reduce the remainder again ten times, or a total attenuation of 100 times. We can see now how the use of resistor matching pads helps eliminate oscillator radiation interference.

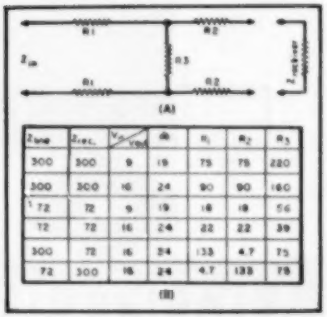
In order to maintain the proper impedance match between the transmission line and both receivers, the resistor network must be balanced and have the correct input and output impedance. In the circuit of Fig. 2, Z_{trans} is the characteristic impedance of the transmission line, such as 300 ohms for the standard TV twin-lead or 72 ohms for some types of coaxial cable. The Z at the other end of the H-pad is the input impedance of the receiver. When the receiver is connected to the pad the impedance looking in at Z_{trans} should be exactly the same as the characteristic impedance of the transmission line. Therefore, a resistor of the same value as the receiver impedance must be connected across these terminals to maintain correct termination of the transmission line when one receiver is not connected to the distribution system.

The table of Fig. 2 gives some actual values for H-pads used in multiple TV installations. Matching receivers to a line having the same impedance, as in the first four examples of the table, permits fairly low losses and low attenuation. Voltage ratios of 9:1 and 16:1 are shown here, resulting in attenuation of 19 and 24 db respectively. It should be kept in mind that the reduction in oscillator radiation will be twice the attenuation, or 38 and 48 db. In the case of matching a 300 ohm line to a 72 ohm receiver the minimum losses exceed the 9:1 or 19 db figure and therefore only the 16:1 or 24 db examples are given. The values of resistors shown in this table are chosen for their closeness to standard components. In order to avoid resonant circuits the wirewound type of resistor should not be used for these pads, but only $\frac{1}{2}$ watt carbon composition types employed. The actual construction of an H-pad as described here is quite simple, but a few rules must be observed. Unless 5% tolerance resistors are used it is advisable to measure a number of resistors with a correctly calibrated ohmmeter and select those closest to the prescribed values. If possible both R_1 resistors should measure the same, even if the value is slightly different from the desired one. The same applies to the two R_2 resistors. This is recommended to avoid unbalancing the input to the receiver. To maintain the correct impedance and keep stray capacities at a minimum, the smallest resistor, not over $\frac{1}{2}$ inch long, should be used. Keep all leads very short, preferably less than $\frac{1}{4}$ inch. Soldering such short leads tends to heat up the resistor excessively and special care should be taken to make a good solder connection without applying too much heat to the resistors. Many technicians mount an H-pad on a small piece of bakelite or polystyrene to keep all parts in place, while others use a layer of polystyrene or Scotch tape to add some rigidity and insulation. Under no circumstances should such a pad be taped up with ordinary electrician's or any paper based tape, since this might reduce the impedance and result in mismatch.

In a multiple installation using resistor pads, the best location for the pad is near the receiver antenna terminal. Remember that an unused pad must be terminated with an additional resistor of the same value as the receiver's input impedance. Actual experience shows that up to ten receivers can be operated from a single antenna giving 10,000 microvolts of signal or more provided that the distance between receivers is not less than 10 and not more than 50 feet. If sets are too close, radiation through the air will undo the work of the attenuator pads. At distances beyond 50 feet the losses due to the long transmission line will become large enough to seriously reduce the useful signal.

Fig. 1. Circuit for coupling two receivers by means of resistor matching pads and isolating condensers of suitable size.





Z_{trans}	$Z_{rec.}$	$\frac{V_{in}}{V_{out}}$	db	R_1	R_2	R_3
300	300	9	19	75	75	220
300	300	16	24	90	90	180
72	72	9	19	18	18	56
72	72	16	24	22	22	39
300	72	16	24	133	4.7	75
72	300	16	24	4.7	133	75

(B)

Fig. 2. (A) Network for matching two receivers of different characteristic impedances. (B) Table of values for H-pads as used in multiple television installations.

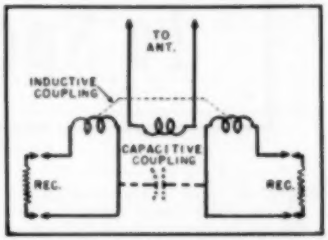


Fig. 3. Commercial-type coupler used to connect two to four sets to one antenna.

Commercial Antenna Couplers

Several TV accessory manufacturers offer coupling devices that permit two or four TV sets to be operated from one antenna without the use of resistor pads. One type of circuit found in these units is shown in Fig. 3. This is effectively a simple r.f. transformer with the primary connected to the antenna and two secondaries for the two TV receivers. The actual appearance of this device is more like that of the elevator transformer input circuit used in many TV tuners to permit either a 300 or 72 ohm input. An effort is made to minimize the capacitive and inductive coupling between the two windings going to the receivers to reduce oscillator radiation. Nevertheless there is considerable coupling between the two sets and oscillator radiation may

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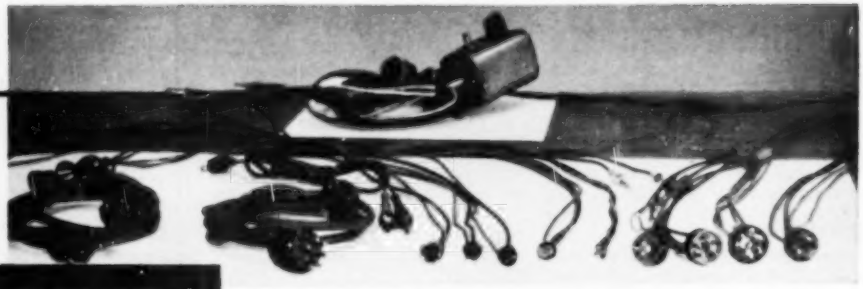

The different types of speaker-connection adapters, used with bench speaker. Unit in background is used for bench-testing of Motorola two-way FM receivers. Box contains volume control, switch, and squelch control. The large units in the left foreground are used to test Wurlitzer and Rock-Ola juke box amplifiers.

ADAPTERS To Speed Up Your Service

By JACK DARR

Many tedious service procedures can be expedited by adopting these unique technician-tested aids.

TIME saved is money earned, in anybody's shop. Your service bench itself can be a tool—an actual test-instrument—with a few simple additions. A test speaker, a few resistors and switches, an old choke or field coil, a small panel with a d.c. ammeter and binding-posts, together with an easily-built set of adapter harnesses and test leads, can earn several dollars each month and make your work a lot easier.

Testing radio or TV chassis without pulling the speaker; testing p.a. systems or juke-box amplifiers under load; checking auto radios without removing the speaker from the car; testing two-way FM radio equipment without pulling the control heads; locating distortion, rattles, noisy transformers, or field coils; all of these procedures and more can be done easily with a gadget like this. The one described was set up to fit our requirements. Yours can be different, if you have different equipment to work on. The whole thing can be built out of junk-box parts, if desired, for a small outlay of cash. Ours is built into a panel of the bench. It could be built into a small box, if it would be more convenient.

Bench power panel used to test an auto radio. Ammeter on right measures drain of set, meter on left measures charging current into battery. Switch in the center controls battery charger. Note extension jacks at right of photo. These are connected in parallel with jacks on main test speaker panel. A similar test set at the other end of the bench, increases usefulness of the set.

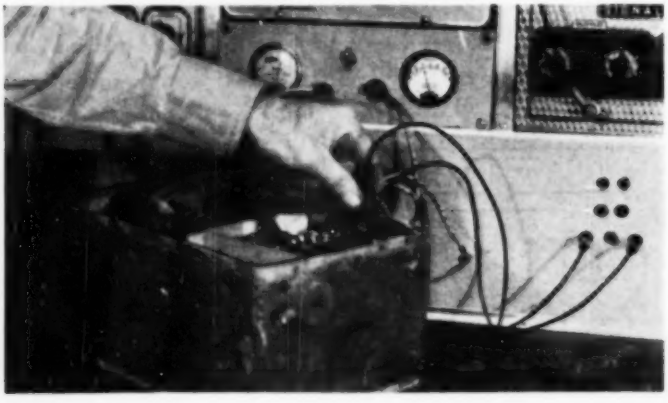

Fig. 1A is the schematic of the bench-speaker assembly and its connections. The speaker is a salvaged 8-inch PM unit which has been reconed. T_1 is a 10,000 ohm, center-tapped, output transformer, also salvaged. R_1 is a 16-ohm, 25-watt resistor, for testing p.a. and juke-box amplifiers. R_2 is a 10,000 ohm, 50-watt resistor, tapped at 5000 ohms, which is used as a substitute field on juke boxes. SO_1 is a heavy-duty octal socket, used with adapter cables for juke box testing. Extensions are run from the voice-coil field and output-transformer wires to the ends of the bench, to eliminate moving the chassis or having to use excessively long wires. These are connected in parallel with the jacks on the main panel. Only one set may be connected at a time, of course. S_1 is used to disconnect the voice coil from the transformer, if necessary. L_1 is an old 1000-ohm speaker with a bad voice coil, however, a choke could be used here instead. S_2 is the "*VC Resistor*" switch, used with R_1 for p.a. system tests. Pin jacks are also connected to this resistor for use if needed.

Now, let's put it to work. Although there are a lot of different speaker plugs in use, from the tiny *RCA* phono-type plug up to a heavy-duty, 6-pin unit on p.a. systems, there is just barely enough standardization to let us get by without having to build a warehouse to hold them all. A standard 4-, 5-, 6-, and 7-pin, male, the 4-, 5-, and 6-pin "recessed male" type and similar female types, a plug such as used on 1.4-90 v. battery packs, a

standard 1.4-volt "A" battery plug, and about a half-dozen special plugs for the non-standard sets, will take care of over 90% of the sets encountered. If you have quite a few of one particular model, it'll be worth-while to order a speaker plug from the manufacturer or your distributor. *Philco, Stromberg-Carlson, RCA,* and many others have these special plugs, which can be purchased for only a few cents each.

In addition to the plugs, you'll need two pairs of test leads, 36 inches long, with pin tips on one end, and insulated alligator clips on the other. With these, any non-standard plug can be jumpered and connections made to the proper places inside the chassis. We use standard pin-jacks for the speaker connections and banana jacks for the field. One pair of test leads, 36 inches long, will suffice here. With these three pairs of leads, any set can be connected for testing, even if you don't have the correct plug.

A new adapter can be made up in about five minutes, if you have the plug and a schematic of the set with which it is to be used. For hooking up adapters to work with a center-tapped output transformer, for instance, it's handy to color code them; use a red wire for the "B-plus," and black for the plates. This is the reason we used different jacks for the field; they can be hooked up quite a bit faster if you do not have to trace them out each time.

Automobile radios may be serviced faster by using adapters for the connecting leads. Many of the speaker adapters just mentioned can be used on both auto and home radios. The "hot" leads will require special adapters. Get one of each type fuse holder and put them on about an 18-inch length of at least #6 flexible wire. A heavy battery-clip is used for the ground connection. The battery connections on the panel are brought out to two binding posts. Heavy spade lugs are used on the ends of each lead.

Fig. 1. (A) Schematic of test speaker and accessory panel. S1 is used to select voice coil of speaker or load resistor for amplifier testing only. (B) The auto radio test panel. The 30-0-30 ammeter was salvaged from a "defunct" Delco plant. The "battery booster" is a 4-ampere trickle charger. The switch is in the primary of the booster. (C) The adapter cable used to connect juke box amplifier to test speaker panel. This cable fits most Rock-Ola amplifiers. Cables can be made up to fit any amplifier. P_1 is an Amphenol male octal shell-plug while P_2 is a standard Amphenol male, five-prong plug.

An ammeter is hooked in series with one of the battery wires in the panel (See Fig. 1B). Some of these will require a fuse in order to make the connection. Bridge the fuse with a piece of wire soldered to the caps. With the ammeter in the circuit you don't need a fuse for protection as any overload will show up instantly and it is annoying to have the fuse blow in the middle of a job.

Mobile two-way radio equipment can also be serviced quickly with this same equipment, using a special adapter. Receivers and transmitters use a remote control head with the volume and squelch controls, switches, pilot lights, microphone plugs, etc. mounted in it. We built a dummy head, using two standard volume controls, a switch, and two plugs. The cabling is simple as we omitted pilot lights, etc., and used only the essential wires. Using this, a receiver can be connected for test in about one minute. The transmitter could also be hooked up in a similar manner but thus far we haven't found it necessary. If we do, we'll hook up the necessary set of plugs and a harness.

Juke boxes, p.a. systems, and musical instrument amplifiers can be tested for power output by using the heavy-duty load resistor and measuring the voltage developed across it. As we do quite a bit of juke box work, we made up the special adapter cable shown in

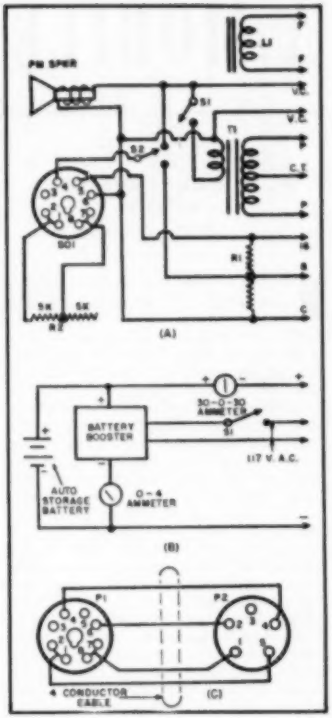

Fig. 1C. This cable and plug assembly fits most *Rock-Ola* juke boxes. Any other make could be connected in the same way. A word of caution here; don't connect the full output of p.a. systems, etc. across this kind of speaker, and then wonder why the voice-coil smokes! If you want to hear it, add a small condenser from the resistor to the speaker, or turn the gain down.

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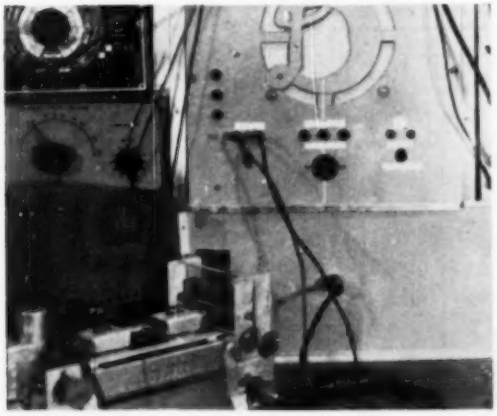
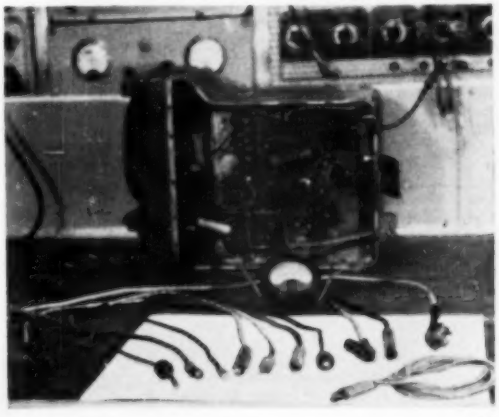
Bench speaker unit. Left-hand vertical connections are used for dummy load resistor. Octal socket in center is used with speaker and load resistor for juke box and p.a. system tests.

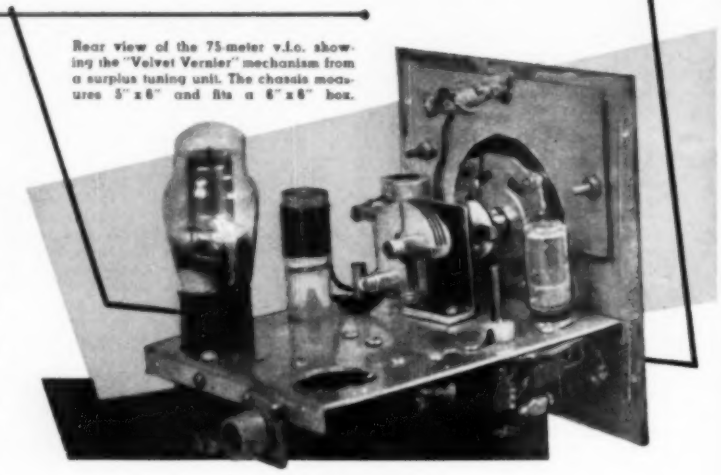


Adapters used to connect auto radios to bench power panel for testing. Ground clip is at right. Meter is portable, with home-made shunt, for testing in cars. Connectors replace set's fuse.



A MOBILE 75-METER V.F.O.

By
W. O. CRUSINBERRY, W9DVV
Instructor, De Forest's Training, Inc.



Rear view of the 75-meter v.f.o. showing the "Velvet Vernier" mechanism from a surplus tuning unit. The chassis measures 5" x 6" and fits a 6" x 8" box.

Construction details on a compact unit which has been designed for front-panel mounting in a car.

IT ONLY takes two or three days of operation on 75 meters for one to realize the futility of trying to operate with crystal control alone. This is especially true in mobile operation due to the relatively low power that most of us must use. Therefore the v.f.o. described in this article was constructed for installation in the author's car, and designed for front panel mounting so that the bulky components of the final and the modulator could remain in the trunk compartment. The unit has been quite successful in this installation and has proven very stable even under severe mechanical vibration and the varying voltage conditions present in most mobile power supplies.

The unit was built with the idea in mind that it would be used with an existing crystal-controlled transmitter and the original oscillator could be retained in the event that one desired crystal control facilities in addition to the v.f.o. Therefore this v.f.o. can be readily adapted to most of the conventional mobile transmitters without the necessity of altering or rebuilding the existing crystal oscillator or driver stages. The circuit also includes facilities for energizing the v.f.o. alone so that one may QSY with the final off.

Circuit

A 6AK6 was chosen for the oscillator tube itself and the conventional Clapp circuit is used. Bench tests indicated slightly better frequency stability with the Clapp, under varying supply voltage conditions, than with the Hartley circuit.

The main tuning condenser is C_1, and zero temperature coefficient condensers are used at C_2 and C_3. The bandset condenser is C_5, and with the values shown in Fig. 2 the 75-meter band, from 3.85 to 4.0 megacycles, is spread out over almost the full 180 degrees of the tuning condenser rotation.

The buffer stage also utilizes the 6AK6 and is straightforward in design. The plate tank circuit of this stage uses a slug-tuned coil which is broad enough in its inherent tuning characteristics so that, if it is tuned to resonance near the middle of the band at 3.9 megacycles, it will not require retuning over the desired frequency range of operation. Shunt feed is used in the plate circuit and therefore one end of the coil may be at chassis ground for simplicity in mounting.

The output of the buffer is link coupled to the final which, in the author's installation, is nine feet away in the trunk compartment. RG59U coax, coupled with a four-turn link around the cold end of L_6, is used for this run of nine feet.

It was found expedient to use a voltage regulator tube for stabilization of the oscillator voltage in the v.f.o.

There will often be a variation of as much as 50 volts in most mobile power supplies between full battery charge and the run-down condition that exists after operating a couple of hours. The 8 to 10 mils that the voltage regulator draws in extra current is well repaid in frequency stability.

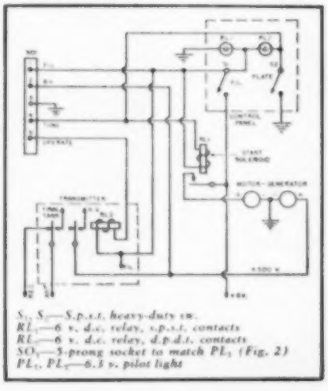
The v.f.o. was constructed, in our case, on an old chassis that at one time was a mobile converter. The chassis size is 5 by 6 inches and mounts in a standard 6-inch square utility box. However, as can be seen from the photographs, there is a great deal of space left on the chassis. It would therefore be possible to use a smaller size, say 4 by 5, which would result in a much more compact finished unit. A miniature VR tube is available which would allow the use of a smaller cabinet.

Mechanical stability is far and above the most important consideration in the mounting of the oscillator components. Bear in mind that a v.f.o. used in a car is going to be subjected to much more severe mechanical vibration than one used in the shack. The parts, especially tuning components, must be mounted firmly on the chassis so that there will be absolutely no movement between the parts and the chassis. All bolts should be tightened firmly and lock washers used wherever possible.

Reference to the photographs will show that the model uses a "Velvet Vernier" mechanism from a surplus tuning unit. This vernier has a knob-to-condenser-shaft reduction ratio of 2.5 to 1; however, any comparable vernier will do. The dial itself was fabricated with a scale drawn in India ink and a pointer attached to the condenser shaft. The dial face is separated from the front panel by about ⅛ inch, which allows the light from a pilot bulb, mounted inside the cabinet, to shine on the face.

The switch on the left of the front panel applies filament voltage to the

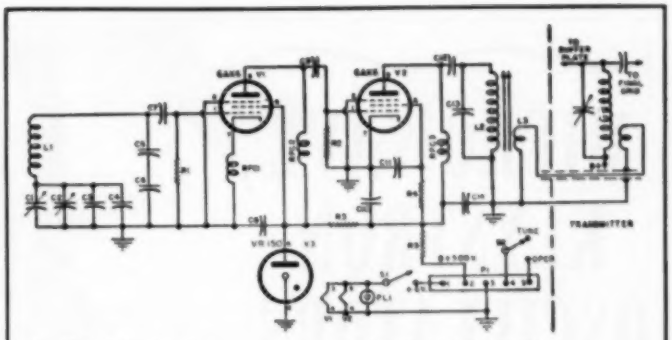
Fig. 1. Method for connecting S_1 (Fig. 2).



S_1, S_2—S.p.s.t. heavy-duty sw.
RL_1—6 v. d.c. relay, s.p.s.t. contacts
RL_2—6 v. d.c. relay, d.p.d.t. contacts
SO_1—5-prong socket to match PL_1 (Fig. 2)
PL_1, PL_2—6.3 v. pilot light

unit, and the switch on the right is a "Tune-Operate" switch. This allows application of supply voltage to the v.f.o. alone for the purpose of tuning to a desired frequency with the final off.

Fig. 1 is a diagram showing how the "Tune-Operate" switch (S_5, Fig. 2) on the v.f.o. is wired into the regular mobile transmitter and control panel circuits. As can be seen, if the "Tune-Operate" switch is in the "Tune" position, it opens the circuit to the main "B+" and antenna relay RL_2 in the transmitter. If the regular plate switch on the control panel is now actuated, it will start the dynamotor and high voltage will be applied only to the v.f.o. Since RL_2 does not energize, there will be no plate voltage applied to the final and the antenna will remain connected to the receiver. After the desired frequency is set, by the dial calibrations or by "zero beating" in the receiver, the transmitter final can be energized by turning the "Tune-Operate" switch to "Operate." Variations, of course, can be made at the discretion of the individual to make the control circuit applicable to his own installation.



R_1—100,000 ohm, 1 w. res.
R_2—27,000 ohm, 1 w. res.
R_3—8000 ohm, 1 w. wirewound res.
R_4—22,000 ohm, 1 w. res.
R_5—3750 ohm, 10 w. wirewound res.
C_1—35 μμfd. var. cond. (Hammarlund MC Midget)
C_2—100 μμfd. var. cond. (Hammarlund HFA Midget)
C_3—50 μμfd. zero-temp. coefficient ceramic cond. (NPO Ceramicon)
C_4—75 μμfd. zero-temp. coefficient ceramic cond.
C_{11}, C_{12}—.001 μfd., mica cond. (Could use a 500 μμfd. mica cond. in place of C_{11}, C_{12})
C_{13}, C_{15}—100 μμfd. mica cond.
C_{14}, C_{17}—.05 μfd., 400 v. cond.
C_5, C_{16}—56 μμfd. ceramic cond.
C_{18}—8 μfd., 400 v. elec. cond.
C_{19}—.01 μfd., 400 v. cond.
L_1—26 t. #18 p.e. closewound on ¼" dia. form, 8.6 μhy. inductance
L_2—40 t. #22 p.e. closewound on ½" o.d. slug-tuned form. Slug dia. ⅜", length ¼" (National XR 50 form)
L_3—4 t. insulated wire wound around gnd. end of L_2
RFC_1, RFC_2, RFC_3—2.5 mhy. r.f. choke
PL_1—6.3 v. pilot light
S_1—S.p.s.t. sw.
S_2—S.p.s.t. heavy-duty sw.
P—3-terminal plug
V_1, V_2—6AK6 tube
V_3—VR150/30 tube

Fig. 2. Circuit diagram of v.f.o. and method of coupling it to the transmitter.

Coupling to the Transmitter

As mentioned previously, it is likely that no changes will be required in the transmitter circuit in order to drive it with the v.f.o. The right hand portion of the diagram of Fig. 2 (set off by dotted lines) shows the circuit of the buffer plate tank in this installation. The coax from the v.f.o. is simply link coupled, with about four turns, to the r.f. ground end of the buffer tank coil in the transmitter. If the transmitter has a tuned grid circuit in the final the link should be coupled to it instead of the buffer. When using the v.f.o. with a crystal-controlled transmitter, be sure to remove the crystal from its socket. In the event that enough drive is not available from the v.f.o., such as might be the case with a triode final, the unit could be coupled to the grid circuit of the buffer stage of the transmitter to provide an additional stage of amplification. In order to reduce the total current consumption of the transmitter, the tubes which are not used, when coupled to the v.f.o., should be removed from their sockets. A coax connector is used at the transmitter end of the coax to facilitate changing back to crystal control. To do this the coax is simply disconnected and the tubes and crystal replaced in the transmitter.

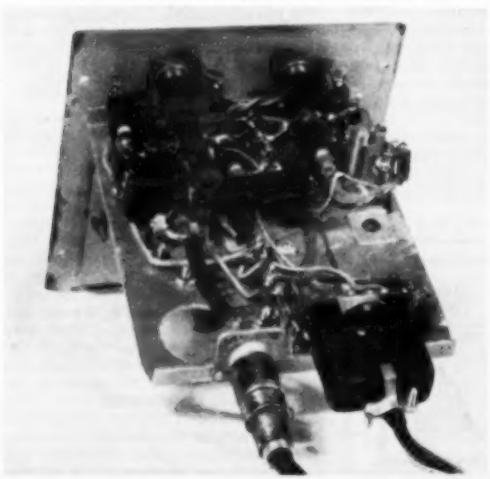
Alignment and calibration of the v.f.o. are relatively easy. Any receiver of reasonable accuracy can be used, and if it is first checked against the 5 megacycle WWV signal it will suffice for use in calibrating the v.f.o.

It is suggested, however, that after calibration the operator respect the band edge limits to the extent of 10 or 15 kilocycles. A grid dip oscillator should also provide an excellent means of calibrating the unit by beating in a receiver.

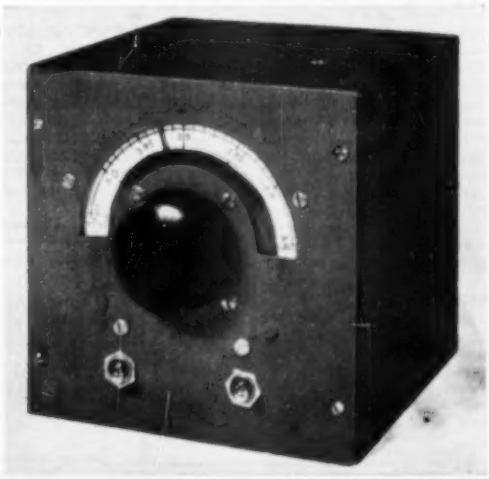
Before the calibration process can begin the v.f.o. must be placed in its

(*Continued on page* 104)

Under chassis view of the compact, mobile 75-meter v.f.o.

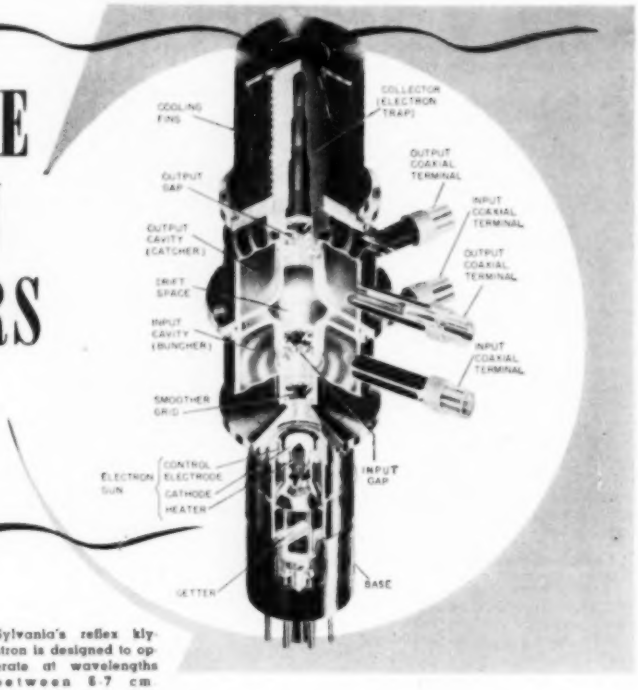


Front panel view of unit showing the simplified controls.



MICROWAVE KLYSTRON OSCILLATORS

By
JOSEPH RACKER*
and
LAWRENCE PERENICH†



Sylvania's reflex klystron is designed to operate at wavelengths between 6.7 cm

Part 1. Practical operating data on klystrons as used in present-day communications equipment.

MICROWAVE frequencies are being used to an ever-increasing degree in commercial television and communications links, amateur transmission, and a long list of governmental and industrial electronic devices such as radar, instrument landing, guided missiles, and air traffic control. Consequently, the field of microwave techniques offers an excellent opportunity to technicians and engineers, as well as providing interesting equipment for ham operation.

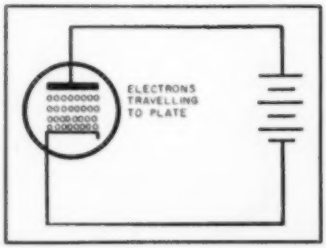
Fig. 5 is a block diagram of a typical transmitter and receiver operating at microwave frequencies. As seen in this diagram, all stages except the microwave *oscillator* in the transmitter and input circuit and local *oscillator* in the receiver, operate at conventional frequencies. This illustrates a very important fact, namely, a thorough understanding of microwave oscillators and their associated circuits provides the reader with a very substantial basis for servicing and building many microwave systems. In other words, generally speaking, a microwave transmitter is no more than a conventional type transmitter which uses a microwave oscillator. A microwave receiver is a standard superheterodyne circuit using a microwave local oscillator and input circuit.

There are a number of methods of generating energy at microwave frequencies including lighthouse oscillators, magnetrons, traveling wave tubes, and klystrons. The klystron oscillator, which is the subject matter of this article, is by far the most commonly used oscillator, particularly in commercial equipment.

For reasons that need not be discussed in this article, it is extremely difficult and inefficient to generate microwave energy using conventional techniques and tubes. Of the microwave oscillators listed, only the lighthouse tube uses standard oscillator circuits. This type of oscillator, however, has an upper frequency of about 4000 mc. All of the other oscillators, sometimes called transit time oscillators, employ new and different techniques of oscillation.

Since entirely new techniques are involved, the authors have divided this article into two parts. The first part describes the basic theory of klystron operation so that a reader who has never had any previous microwave experience can understand how it works. The second part covers the practical aspects of the klystron oscillator, namely, its construction, characteristic curves, methods of tuning, modulation, and servicing. Needless to say, the reader cannot absorb the material presented in the second part unless he understands the theory outlined in the first part.

Fig. 1. Electron flow in a diode tube.



Conservation of Energy Law

A very familiar universal law—conservation of energy—which is rarely used in electronic theory becomes very important in klystron and other transit time oscillator operation. They are called transit time oscillators because the energy required to sustain oscillations is obtained from the electron stream while it is *in transit* between cathode, or electron gun, to plate, or collector. In order to understand how this energy is transferred, the conservation of energy law must be applied to the electron flow.

Consider the flow of an electron that leaves the cathode of the diode, shown in Fig. 1, and travels toward the plate. When the plate is positive with respect to the cathode, the electron is accelerated toward the plate. Whenever any mass, including an electron, is acceler-

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ated it picks up energy. From the law of conservation of energy it is known that this energy must come from some other element in the system.

Actually, in this case, the energy comes from the battery. This is most easily seen at the instant that the electron actually reaches the plate. At this time the electron would normally neutralize a positive charge and the plate potential would decrease. However, the battery has been expending energy and drawing an electron away from the plate, as the transit electron approaches it, so that when the electron actually reaches the plate there is no net change in charge and the plate potential remains constant. The most important fact, however, is that when an electron is accelerated, it gains energy, and this energy comes from some element in the system.

Similarly, if the plate potential is negative, the electron is retarded, or slowed down, by the plate. When an electron is retarded, it is giving up energy. Thus when it approaches the plate it repels an electron on the plate toward the battery. This, in effect, means that energy is being returned to the battery.

Now let us apply this law of conservation of energy to an electron flowing in an electric field such as can exist in the cavity described in a later paragraph. If the electron is accelerated by the field it is gaining energy which must come from the field and make it weaker. Hence an electron that is accelerated by the field causes the field strength to decrease. Conversely, an electron that is retarded by the field, loses energy to, and increases the field strength. In this article, the direction of the electric field will be depicted by an arrow and the magnitude of the field by length of arrow. An electron flowing in the direction of the field is accelerated by it (some texts use the reverse convention), while an electron flowing against the field is retarded by it.

Flow in Cavity Resonator

At microwave frequencies a special type of tuned circuit, known as a cavity resonator, or simply a cavity, is required. The cavity is a hollow metallic box which can be rectangular, cylindrical, spherical, or a number of other shapes. Several common types of cavities are shown in Fig. 2. The cavity is usually about one-half wavelength long (wavelength as measured in the cavity), although it can also be any multiple number of half wavelengths long.

In any tuned circuit, such as the conventional *LC* tank at conventional frequencies, there is a continuous exchange of energy from magnetic to electric field, and *vice versa*. For example, in the *LC* circuit the energy stored in the magnetic field around the coil is transferred into the electric field, building up in the condenser, as the current in the circuit declines. During the next half cycle, as the condenser discharges, the condenser electric field

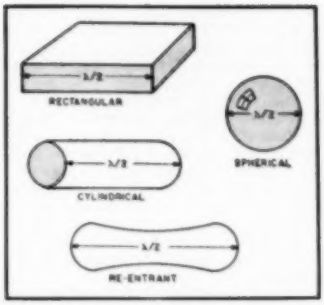


Fig. 2. Several common types of cavities.

energy is transferred into the magnetic field which is being generated around the coil.

In a cavity this continuous exchange of energy takes place in the air within the cavity. In a one-half wavelength rectangular cavity, for example, the electric field exists sinusoidally along the length of the cavity as shown in Fig. 3. The field is always maximum at the center and reduces to zero at the ends. The magnetic field in the cavity also has a sinusoidal variation, being maximum at the ends and becoming zero at the center. In Fig. 3, three instantaneous values of the electric field distribution are shown. In Fig. 3A, the electric field is at its maximum intensity. In Fig. 3B, which occurs a short time later, the entire field is declining (and beginning to build up the magnetic field). In Fig. 3C, the field has undergone a half-cycle of operation (since 3A) and is at its maximum negative value.

Just as in any tank circuit, the intensity of the electric field during each successive cycle would decrease slightly, due to small energy loss—equivalent to resistive loss—unless some method of replenishing this energy is available. This can be done by use of an electron stream. Assume that, as shown in Fig. 4, a small slot is inserted at the center of a rectangular cavity

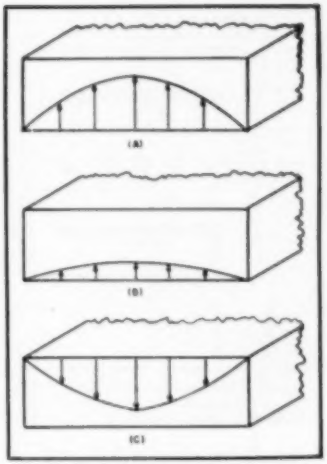


Fig. 3. Electric fields in rectangular guide.

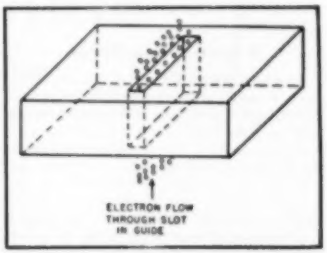
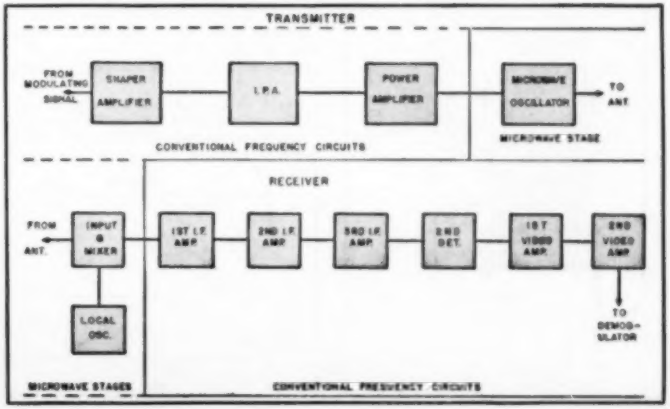


Fig. 4. Electron stream flowing through the slot in a rectangular wave guide.

and an electron stream is directed through this slot. When the electric field of the cavity is so directed (positive half-cycle) that it accelerates the electrons, energy is transferred from the field to the electrons and the field intensity diminishes and oscillations are damped out. However, if the field is so directed (negative half-cycle) that

Fig. 5. Block diagram of a conventional microwave transmitter and receiver.



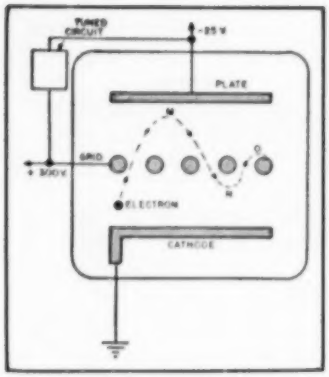


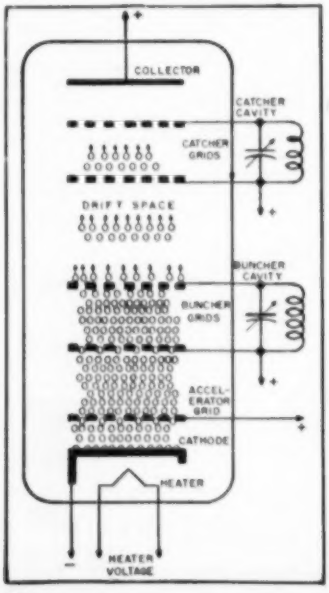
Fig. 6. The electron motion in a positive-grid (Barkhausen-Kurz) type oscillator having constant electrode potentials.

it retards the electron flow, then energy is transferred from electrons to field, and oscillations are sustained. This is the basic principle of klystron operation.

Velocity Modulation

In the foregoing example, if the electron stream were passed through the cavity with uniform intensity, it would increase the field during one half-cycle and decrease it during the next half-cycle and there would be no net exchange of energy. However, if we could arrange the electron stream so that the density of electron flow during the field negative half-cycle is much greater than the density during the positive half-cycle, then there would be a net exchange of energy from electron stream to the field. The process by which the electron beam is "bunched" in this manner is known as bunching or "velocity modulation."

Fig. 7. Basic representation of klystron.



The velocity modulation action is best understood by considering the operation of the simplest type of velocity modulation oscillator called the positive grid, Barkhausen-Kurz, or retarding field oscillator. In this type of oscillator, shown in Fig. 6, the grid is operated at a positive potential with respect to cathode and plate, and the plate is negative with respect to the cathode.

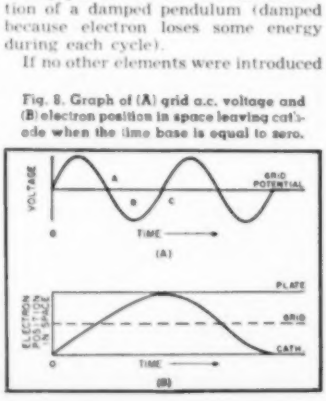
The operation of this circuit will be considered first under d.c. conditions and then with an a.c. voltage applied to the grid. In addition, although the complete action involves many electrons, it will be simpler to first investigate the behaviour of a single electron. Then, later, the reasoning thus obtained will be extended to entire groups of electrons.

Consider the flow of an electron leaving the cathode of the tube shown in Fig. 6 with the tank circuit shorted out (no a.c. voltage on grid). As an electron leaves the cathode it is accelerated toward the grid by its high positive potential. By the time the electron reaches the grid its velocity is high and it may either hit the grid, delivering its energy in the form of heat, or —more likely—it will pass through the space between grid wires into the region between grid and plate. In the grid-plate region the electric field is in the opposite direction because the plate is negative with respect to the grid. This field tends to slow down the electron and for this reason the oscillator is sometimes called the "retarding field" oscillator.

If the plate voltage is sufficiently negative, the electron will come to rest at some point in space between the grid and plate. The attraction of the grid then causes the electron to reverse direction and move back toward the grid. The electron then swings back and forth past the grid (path *M*, *N*, *O*) until it eventually hits one of the grid wires. The phenomenon is very closely parallel to that of the oscillation of a damped pendulum (damped because electron loses some energy during each cycle).

If no other elements were introduced in the circuit many individual electron oscillations would occur in the space between plate and cathode, causing equivalent energy oscillations in the grid circuit. The exact phase and amplitude of these oscillations between any two electrons would depend upon the time at which the electrons were emitted and the space charge at that time. It is obvious that under these conditions no useful oscillator energy can be supplied to the grid circuit, since the electron oscillations are random and cancel each other.

Fig. 8. Graph of (A) grid a.c. voltage and (B) electron position in space leaving cathode when the time base is equal to zero.



Now assume that an a.c. voltage is superimposed upon the grid (tank circuit no longer short circuited). The frequency of this signal is so high that by the time the electron travels from cathode to the grid, the voltage has changed one-half of a cycle, for example from maximum positive to maximum negative, or from zero to zero, and so on. This is shown in Fig. 8 where (*A*) plots the a.c. voltage and (*B*) the oscillatory (no energy loss) electron path. Let us define the velocity, v_0, as the velocity of the electron at any point in the cathode-plate space with grid potential at the d.c. value shown in Fig. 6.

Consider the relative velocities of the electrons leaving the cathode during grid a.c. potential of *A*, *B*, and *C* shown in Fig. 8A. An electron leaving during time *A*, travels at a velocity less than v_0 in the cathode-grid plane because during this time the grid is always at a negative a.c. potential. It loses more velocity between grid and plate since during this time the grid is positive. Thus, its over-all velocity is less than v_0.

An electron leaving the cathode with grid potential at *B* will travel at about v_0, since during both its cathode-grid and grid-plate paths the grid is positive half the time and negative half the time. Finally, an electron emitted at time *C* will travel at a velocity greater than v_0, since the grid is positive (a.c.) when it is in the grid-cathode plane and negative in the grid-plate plane. It is readily seen that the electrons emitted at time *C* tend to catch up with electrons emitted at time *A* so that electrons will tend to oscillate in bunches instead of completely at random. Now useful oscillatory energy can be supplied to the grid circuit.

Klystron Operation

Basically, the klystron, as shown in Fig. 7, consists of an electron gun, "buncher" and "catcher" grids, and a collector. The electron gun is similar to those found in cathode-ray tubes and functions to provide a steady stream of electrons. The buncher and catcher grids are part of the cavity resonators, slotted in the center using the same principles shown in Fig. 4. The electron stream is velocity modulated by the buncher grids and converted to microwave energy in the catcher grids. Electrons passing through the catcher grids are removed from

(*Continued on page* 122)

Fig. 1. The new Channel Master "Supermount" antenna stacked horizontally. The unit features adjustable structure.

STACKING FOUR Z-MATCHED YAGIS

By HARRY GREENBERG* and HAROLD HARRIS†

A new mechanical and electrical system incorporating a simple mounting arrangement and a new impedance matching harness.

A PRACTICAL system for stacking four yagis by extending the principle of impedance matching which led to the development of the "Z-Match" yagi system has been developed by *Channel Master Laboratories*. The resulting gains of over 14 db are the highest yet attained in a practical television antenna.

The problem was of a dual nature because the mechanical problems were as formidable as the electrical ones. For instance, if four-bay, half-wave vertical stacking were attempted on Channel 2, the antenna array would require about 25 feet of unguyed mast. On the other hand, on the high band, the length of masting required for four bays is about 10 feet, which is a practical dimension. Therefore, a separate mechanical approach was required on each band, although the electrical problem of phasing and matching was the same. On the low band, the four-bay array was constructed by arranging two stacked yagis side by side. This arrangement was made practical by a new adjustable structure made of heavy welded tubing (Fig. 1). This large mounting framework was trade named the "Supermount."

The adjustable cross boom of the "Supermount" provided for full-wave horizontal spacing between the two stacked arrays. Since full-wave spacing was utilized, the distance between the two stacked arrays ran up to 17 feet on Channel 2. The entire structure was supported at the center. This meant that tremendous twisting torques were developed under brisk winds. This torsion was excessive on most commercial television towers because horizontal stacking narrows the directivity of the antenna and makes it more sensitive to twisting. The twisting problem was solved by guying the array at its outer extremities under each stacked yagi. Guying at these points also kept the guy wires out of the field of the antenna. These guy wires, in turn, created a large downward thrust on the extended booms and this, in turn, was offset by diagonal braces.

Since all of these operations had to be accomplished while assembling the entire array from the top of a tower, the entire structure was designed in two parts so that the spacing between stacked arrays could be adjusted for each channel and so that the diagonal brace could be pivoted to fasten with

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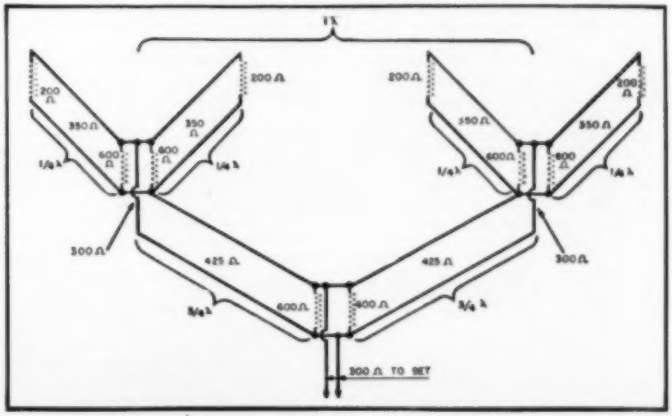
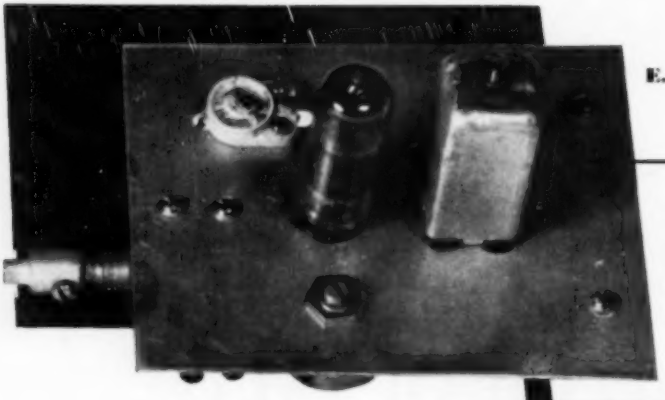
Fig. 2. Operating principle of the four Z-matched yagi antennas.



* Chief Electronic Engineer, Channel Master Corp.
† Vice-president, Sales & Engineering, Channel Master Corp.

An Adapter for NBFM Reception

By
E. FERNANDEZ DE CASTRO



Top view of the small subchassis used to mount the adapter. The screwdriver adjustment is for the cathode potentiometer used for setting the point of best amplitude limiting action of the unit. The ceramic trimmer back of the tube is for compensating the tuning of the last i.f. transformer for differences in the distributed capacities of the wiring. The switch changes operation from AM to FM.

Details on a unique ham application for the recently-introduced 6BN6 gated-beam tube.

ALTHOUGH the advantages of using a suitable FM detecting system in NBFM work are recognized by everyone, most hams still rely on the "off-tuning" method of reception on standard AM sets, thus losing most of the advantages of that type of communication.

Although several types of FM adapters for NBFM work are available at the present time and despite the fact that information on how to build them has often been published, their use is still somewhat restricted because of the difficulty encountered in finding suitable components. Such well-known surplus receivers as the BC-348 and the BC-345 have an i.f value for which no commercial adapters have been designed nor are suitable discriminator transformers available to build adapters for such receivers.

A solution to this problem can be found in the use of the "gated-beam tube" which is available commercially as the 6BN6. This tube, so-called from the way the electron stream is formed and controlled before reaching the anode, makes possible the construction of a simple adapter for NBFM reception without resorting to special components. In fact, the parts required, with the exception of the tube, are among those usually found in any ham's or experimenter's junk box.

The circuit is simple and straightforward. It has given excellent results with every type of receiver with which it has been used and has proved suitable for all types of FM transmission, whether amateur narrow band or broadcast wide band. The limitation on the highest signal deviation that can be received is determined by the selectivity of the i.f. channel of the receiver with which it is being used and not by the adapter itself which is easily adjustable to any desired bandwidth.

The advantages of this unit include the saving of time and money and the elimination of hard-to-get parts. The only resonant circuit required in the assembly can be obtained from a discarded i.f. transformer winding or the secondary of an r.f. coil—a distinct advantage in the case of receivers using an i.f. other than 455 kc.

How It Works

It is a well-known fact that an FM detector operates by providing an audio voltage proportional to the frequency deviation of the carrier—not its amplitude. In fact, amplitude variations of the signal are removed before the detection process by means of one or more limiter stages.

The gated-beam tube takes care of both of these functions, amplitude limiting and frequency detection. In its construction electron optic techniques, together with a special arrangement of the electrodes, have been used to obtain an operational characteristic that is quite different from that exhibited by the usual type of tubes.

Frequency detection with the 6BN6 is provided by off-phase operation of its two grids while an efficient limiting action is obtained by the unusually sharp cut-off characteristics of its curve.

Fig. 1B is a simplified schematic of the electrode arrangement in the 6BN6. From this diagram it is easy to see that in many respects this tube resembles the familiar cathode-ray tube. This similarity can be explained by the fact that in the gated-beam tube the electron stream must be accurately formed and focused on the different control elements in order to obtain its unique performance characteristics.

There are two control grids which influence the plate current flow. The normal control grid is located next to the cathode while the second grid, called the "gating" or "quadrature grid", is near the anode of the tube in the position normally occupied by the suppressor grid of pentode tubes.

The control action of the grids is very steep, resembling the "all-or-nothing" action of the grid in gas-filled tubes. A signal of 1½ volts swings the plate current from cut-off to saturation. This "on-off" action, as the "gate" closes or opens fully, is what gives the tube its name.

Although the principle of operation of the 6BN6 tube as a limiter-discriminator has been covered fairly thoroughly in recent technical literature, it might be well to review briefly its operational behavior.

Electrons emitted from the cathode are formed into a narrow beam by the focusing electrode and directed toward the first control grid. The accelerator electrode around the first grid not only serves to speed the electron beam on its way toward the anode but also acts as a collector for those electrons not passing through the grid, in order to avoid the formation of a space charge which would tend to lower the emission capabilities of the cathode.

The electron lens further shapes the beam and directs it, through the screen grid, toward the aperture in the shield that encloses the anode and the gating grid. The accelerator electrode is tied internally to the screen grid of the tube while the focusing electrode (beam deflector plates), the electron lens, and the anode shielding are all tied internally to the cathode—the

common connection for which is brought to pin 1 at the tube base. The shape and spacing of all these electrodes contributes to the shielding of one grid from the other, thus making their control action independent and sharp.

Fig. 1A is a practical circuit for a combined limiter-discriminator for NBFM reception which the author built for use with a *National* NC-57 receiver.

The signals to be detected are applied to the first control grid, pin 2, through a suitable coupling circuit. Operational bias is provided by the voltage drop in the cathode resistors, one of which is adjustable in order to provide optimum operational conditions for the limiter. The second control grid, pin 6, is returned to ground through a parallel resonant circuit tuned to the operating frequency of the i.f. channel of the receiver. Normal operating voltages are provided for the plate and screen grid of the tube through suitable voltage dropping resistors.

When the signal is impressed on the first grid, the electron beam is modulated in a series of groups or bunches of electrons as the grid potential varies from cut-off to saturation with each positive cycle of the r.f. signal. As the control action of the grid is very steep, all of these pulses will have practically the same amplitude, the maximum value being determined by the plate current saturation and not by the signal amplitude. Limiting of the signals is thus obtained.

The pulses or bunches of electrons are like cyclic variations of the density of the electron's beam and this varying electrostatic charge induces a pulsed current in the gating-grid circuit that flows to ground through the tuned circuit connected at that point. The phase and magnitude of the voltage developed at that grid will be dependent on the resonant characteristics of the circuit and the relation between its resonant frequency and that of the impressed current.

As the frequency of the input signal varies, the phase relationship between the voltages at the control and the gating grid will also vary. As both grids have the same controlling action over the plate current flow, the latter will be in the form of pulses of constant frequency but varying width. The pulses of varying duration are integrated by the plate's *RC* network, the results being a current whose amplitude changes in accordance with the frequency deviation of the signal impressed on the first grid.

The tuned circuit which is connected from the gating grid (pin 6) to ground is the key to the successful operation of the circuit and every effort must be made to obtain a "high-*Q*" unit for this part since the audio voltage obtained at the output of the circuit will be controlled, to a great extent, by the resonant characteristics of this circuit. We used a winding from a 455 kc., permeability-tuned transformer shunted by a 25 $\mu\mu$fd. ceramic condenser and obtained excellent results. If the adapter is to be used with a receiver that, like the B.C.-348, has a higher value of i.f. (910 kc.) the winding from a permeability-tuned broadcast band r.f. coil can be used, shunted by a 50 or 75 $\mu\mu$fd. ceramic condenser.

Precautions should be taken to insure adequate shielding between components of the limiter grid and those of the quadrature grid circuit since any coupling external to the tube will unbalance the phase relationship between grids. Best results will be obtained if the gating-grid tuned circuit is shielded and its leads are kept well separated from the limiter grid connections.

Since space requirements for this adapter are modest, the unit can be built into the receiver permanently and a switch can be used to change from normal AM reception to NBFM operation.

In the author's case, it was found necessary to add a small trimmer condenser (a 1.5 to 7 $\mu\mu$fd. ceramic unit) from the plate of the receiver's second detector to ground in order to equalize the tuning of the last i.f. transformer in both positions of the switch since the input capacity of the adapter was found to be slightly higher than that of the second detector of the set.

The *RC* network in the plate circuit acts as an integrator circuit for the plate current pulses and, at the same time, serves as a de-emphasis network. The values given in the schematic were found suitable for NBFM reception with a 455 kc. i.f. channel. Other values of capacitance may be more suitable for other values of i.f. or modulation index.

Adjustments

Once the circuit is built and all connections are checked against the wir-

(*Continued on page* 119)

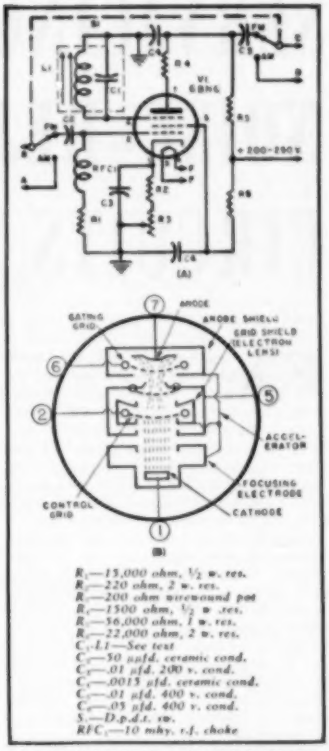
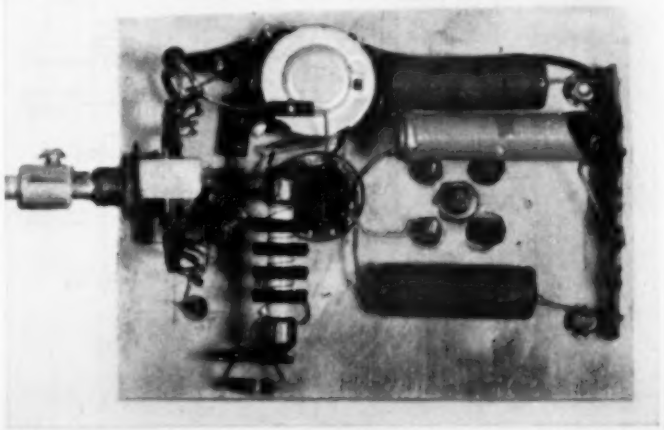


Fig. 1. (A) Schematic of the NBFM adapter. Lead A of the changeover switch connects to the second detector tube in the set. Lead B connects to the secondary of the last i.f. transformer. C is connected to the high side of the volume control, and D to the set's second detector. (B) The arrangement of elements in the 6BN6 tube.

Bottom view of the adapter subchassis. The changeover switch has an extension shaft in order to permit the adapter to be operated from the front panel of the receiver. The terminal strip at the right is used as a tie-point for all the connections which are needed to obtain the necessary adapter voltages from the receiver.



SERVICING NOISE-REJECTION CIRCUITS

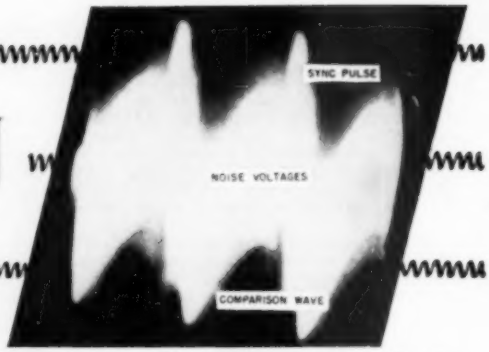


Fig. 1. A properly operating sync amplifier clips the noise pulses to the same height as the sync pulses. Sync is regularly recurrent, noise has a random distribution pattern.

By
P. F. RHODES

Down-to-earth, "how to fix it" instructions covering one important servicing problem.

FIELD experience indicates that the noise-rejection circuits of modern TV receivers are customarily neglected in checking out a set. This is an unfortunate situation, because it is only a matter of luck if the picture is stable under conditions of high local noise level, or normal noise level with a weak signal due to a poor antenna, or to a distant transmitter.

Because noise-rejection tests and adjustments are neglected, it is frequently claimed that receiver A holds sync much better than receiver B under conditions of fringe reception. Next week, another B receiver is discovered to hold sync even better than receiver A. Sometimes the puzzle is resolved by shrugging it off with the comment, "Sometimes you get a good chassis from the factory, and sometimes you get a lemon."

Ridiculous comments of this kind point up the need for better understanding of noise-rejection circuits, and more information concerning the tests which should be made.

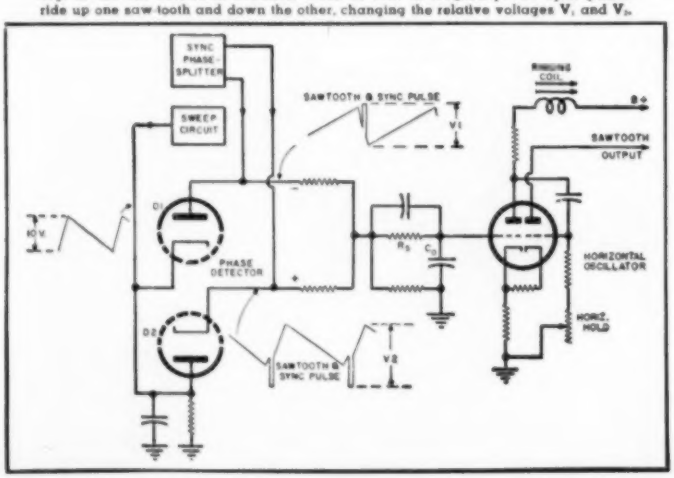
Horizontal A.F.C. Circuits

Forerunners of present-day TV receivers utilized differentiators which triggered the horizontal oscillator directly. These early receivers operated very well in areas of high signal-to-noise ratio. However, it was soon discovered that the picture would tear annoyingly in response to any burst of noise. We can recall the completely unsatisfactory performance of these receivers in weak-signal areas where noise pulses competed continuously with horizontal sync pulses for control of the picture.

Today, every TV receiver is provided with horizontal automatic-frequency-control circuits designed to immunize the horizontal oscillator against false triggering due to noise pulses. Some of these circuits are very clever in conception, and are a tribute to the ingenuity of electronic design engineers.

Three basic principles are used to "sort out" the horizontal sync pulses, and reject noise pulses. The most popular principle employed at present is the averaging-out process, which will be analyzed in detail. The second principle in use operates by means of a noise gate. The third principle is that of the electrical flywheel. One form of the flywheel is sometimes combined with a gate circuit.

Fig. 2. As the horizontal oscillator tends to drift in frequency, the sync pulses ride up one saw-tooth and down the other, changing the relative voltages V_1 and V_2.



Operation of A.F.C. Circuits

Averaging-out circuits take advantage of the fact that sync pulses are regularly recurrent, while noise pulses have a random distribution in time. The sync pulses are added to a comparison wave, as shown in Fig. 2. The comparison wave is obtained from the horizontal oscillator or from the sweep circuit. Most frequently, the comparison wave is a saw-tooth obtained by integrating the voltage waveform from the sweep circuit.

The important considerations are shown in Fig. 2. The conduction of diodes D_1 and D_2 is determined by the peak-to-peak voltages between plate and cathode of each tube. If the horizontal oscillator tends to change frequency, the result is that the sync pulse rides up higher on one saw-tooth, but rides down lower on the other saw-tooth, as shown. As a result, one diode conducts more current, while the other diode conducts less. The combined outputs of the diodes is then no longer zero, but there is a residual positive or negative output voltage which is filtered and applied to the grid of the oscillator. The oscillator responds to this control voltage by returning to its initial frequency.

More important, however, than this mechanism of frequency control is the ability of the circuit to average out noise pulses. A photograph of noise in a phase detector is shown in Fig. 1. (The photo shows noise superimposed

upon a sine wave, which is sometimes used instead of a saw-tooth — circuit action is the same.) It should be observed that the noise is distributed uniformly and at random over the comparison wave. As a result, the two diodes of the phase detector conduct about equally due to noise. *Most of the noise is averaged out at this point.* Of course, we are assuming that the phase detector is truly balanced, with a matched pair of diodes, proper lead dress to avoid unbalanced feedthrough, and similar ideal working factors.

Because noise is random in character, it approaches uniformity in distribution, but does not quite attain uniformity. As a result, there will be a small fluctuation of output from the phase detector due to lack of complete uniformity of the noise. Two circuit actions are utilized to minimize this residual fluctuation. Quite frequently, clipping facilities are provided both in the video amplifier and in the sync amplifier, which operate to clip noise pulses to a common level, provided the noise pulses are higher than the sync pulses. This clipping action contributes to greater uniformity of noise at high levels.

In addition, a delay filter is provided between the output of the phase detector and the input of the horizontal oscillator, as shown in Fig. 2. This delay filter not only smooths out the irregular output of the phase detector to provide a d.c. control voltage, but it also presents a time delay between the application of an input voltage and the appearance of an output voltage. That is, it takes time to charge up the output condenser C_1 through the series resistor R_1.

This time delay smooths out fluctuations due to noise, because these fluctuations vary from positive to negative in a random manner; several cycles of operation must go by at the input to the delay filter before an appreciable change occurs at the output. In this manner, final minimization of noise is accomplished.

Tests for Noise Rejection

One important test for noise rejection is made by inserting a sufficient number of attenuator pads in series with the antenna line to make the horizontal sync become jittery (on the verge of losing sync). If the receiver is correctly adjusted, the picture should be so weak at this point that it no longer has entertainment value.

If the noise-rejection circuits are operating correctly, only the horizontal-hold control and the ringing coil (if used) will require adjustment to obtain satisfactory noise rejection. The horizontal-hold control determines the natural period of the horizontal oscillator, which is normally set as near 15,750 cycles as possible. However, if frequency drift occurs during warm-up, the oscillator should be adjusted after a short warm-up period.

The ringing coil can be adjusted in the same manner for maximum noise immunity. The action of the ringing coil is shown in Fig. 3. During the forward trace, the negative blocking voltage on the grid of the oscillator decays exponentially, and approaches the cut-off voltage level asymptotically. As illustrated, any slight disturbance in the grid circuit can easily cause false early triggering.

However, if we superpose a suitable sine wave upon the exponential, the decay curve no longer approaches the cut-off level asymptotically, but now intersects the cut-off level at an appreciable angle. As shown, grid disturbances have less tendency to cause false early triggering. It might be mentioned in passing that this discussion of the ringing coil operation is a good approach to the concept of a noise gate.

After the horizontal-hold control and the ringing coil have been adjusted, it may be found that the noise-rejection action of the circuit is unsatisfactory: the picture may tear up before it loses its entertainment value. In such cases, it is well to try several different diodes in the phase detector, to find a pair that are most nearly balanced.

If the sync lock is still not tight enough after tubes have been selected, the best procedure is to check the waveforms through the sync-control circuits with an oscilloscope. Not only should the waveforms be correct on both 15.75 kc. sweep, and on 60 cps sweep, but the peak-to-peak voltage of each waveform should check within 20% of the value specified in the receiver service manual. Note in this regard that the line voltage to the receiver must be set at the design-center value of 117 volts. Unfortunately, complete waveform information is not always available, and in such cases the service engineer must rely entirely upon his own ingenuity and experience in circuit analysis.

Incorrect waveforms and incorrect

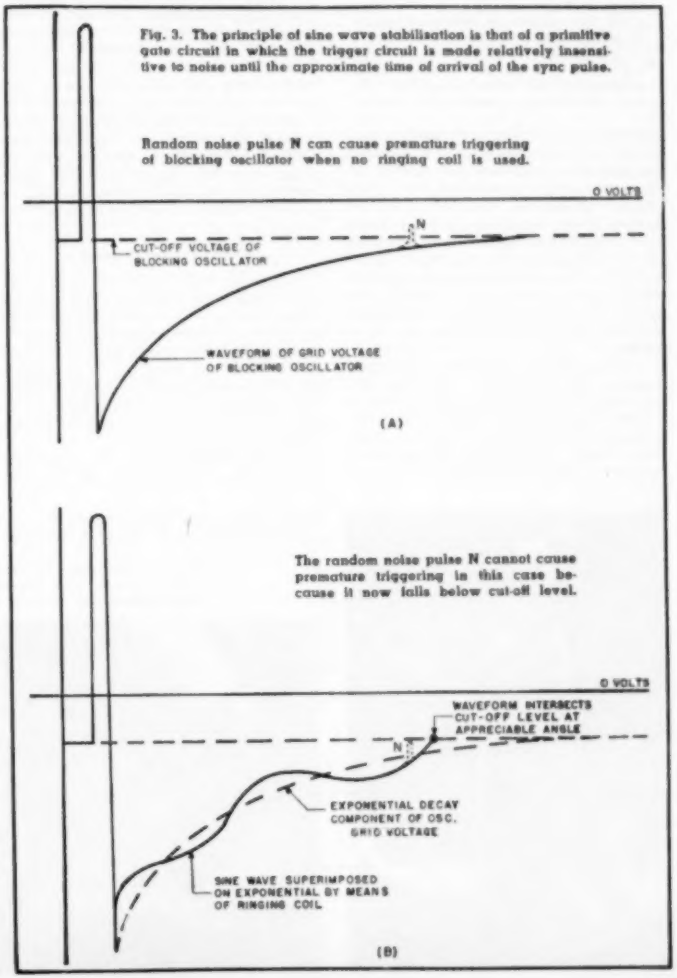

Random noise pulse N can cause premature triggering of blocking oscillator when no ringing coil is used.
0 VOLTS
N
CUT-OFF VOLTAGE OF BLOCKING OSCILLATOR
WAVEFORM OF GRID VOLTAGE OF BLOCKING OSCILLATOR
(A)
The random noise pulse N cannot cause premature triggering in this case because it now falls below cut-off level.
0 VOLTS
WAVEFORM INTERSECTS CUT-OFF LEVEL AT APPRECIABLE ANGLE
N
EXPONENTIAL DECAY COMPONENT OF OSC. GRID VOLTAGE
SINE WAVE SUPERIMPOSED ON EXPONENTIAL BY MEANS OF RINGING COIL
(B)

Fig. 3. The principle of sine wave stabilization is that of a primitive gate circuit in which the trigger circuit is made relatively insensitive to noise until the approximate time of arrival of the sync pulse.

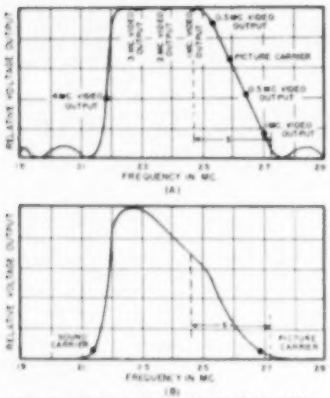


Fig. 4. (A) Sync pulses obtained from this type of receiver response will be adequate. If picture carrier is dropped to the 26.5 mc. point, the pulses will be greatly attenuated. Sync pulses are developed largely on portion of response curve marked "S". (B) Intercarrier response curve, with picture carrier too low on curve. Reduced response at sync pulse frequencies "S", with the resulting unstable sync action.

peak-to-peak voltages usually result from open or partially open condensers, as defective resistors are almost always caught in the routine d.c. voltage check. Of course, there are a few resistors which do not carry d.c. current, and these will be picked up in the scope check. Resistance measurements in TV circuits are complicated by branch circuits and by electrolytic condensers which frequently have to be disconnected before the measurement can be made.

The possibility of improper lead dress must be kept in mind, as "feedthrough" can easily ruin the best noise rejection circuit. Such feedthrough is best discovered by inspection of the scope waveforms. Lead dress is usually OK when the receiver leaves the factory, but may have been disturbed during prior service operations. When evidence of feedthrough is seen on the scope, do not re-arrange the lead dress at random, but carefully study the circuit diagram to determine where the trouble could occur, and then proceed according to plan.

If feedthrough fails to account for waveform contamination, the service engineer should next look for common impedances. In most cases, common impedances are due to electrolytic condensers which bypass two or more circuits; as the bypass capacitance decreases with aging of the condenser, more cross-talk occurs between the circuits.

The possibility of defective soldered joints must not be overlooked as a cause of waveform contamination. Just as a high-reactance bypass condenser can produce cross-talk in common circuit paths, so can a high-resistance connection lead to circuit interaction. Such high-resistance connections can be effectively checked on the low-ohms range of a service ohmmeter.

It is evident that efficient and effective servicing of noise-rejection circuits requires diagnosis of receiver operation at low signal levels, analysis of circuit action via waveform inspection and voltage measurement, and, last but not least important, bringing to the problem all the technical know-how and ingenuity which the service engineer can command.

Use of Instruments

Although this article is primarily concerned with the noise-rejecting circuits of TV receivers, it is perhaps well to point out that proper use of instruments is just as important as competency in circuit analysis. The diagnosis of a circuit fault frequently fails due to misapplication of service instruments. The following points are of major importance:

1. The circuit under test must not be excessively loaded by the test instrument. Know what the input impedance of your instrument is at the highest frequency under test; look at the circuit diagram to determine the approximate impedance at the test point. To be safe, the instrument should have an input impedance at least 10 times that of the circuit under test.

2. If the input impedance of the instrument is unacceptably low, either use a higher-impedance instrument or connect a suitable high-impedance probe between the instrument and the circuit under test. Make certain that the probe is suitably compensated against frequency and phase distortion.

3. Peak-to-peak probes are satisfactory for use with a vacuum-tube voltmeter, provided the impedance of the sync circuit is sufficiently low, and provided the waveform is not a narrow pulse. If in doubt, check the peak-to-peak reading on the voltmeter against the reading on a calibrated wide-band scope. Remember that a voltmeter always reads the highest voltage present, whether it is that of the desired waveform or not. Your scope distinguishes between these components.

We have shown that a practical test of a noise-rejection circuit can be made by inserting a sufficient number of attenuating pads in series with the antenna until the picture either "broke sync" or lost its entertainment value. If the noise-rejection circuits are operating properly, the picture will become too washed-out and too dim for satisfactory viewing, before it breaks sync lock.

We determined that inadequate noise rejection can result from unbalanced diodes in the phase detector, misadjustment of the horizontal-hold control (which places an added burden on the a.f.c. circuit), warm-up drift of the horizontal-oscillator frequency, open or partially-open condensers in the a.f.c. circuits (these do not usually show up on a d.c.-voltage check), and improper feedthrough of various wave-

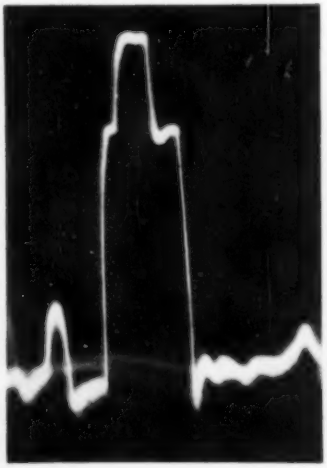
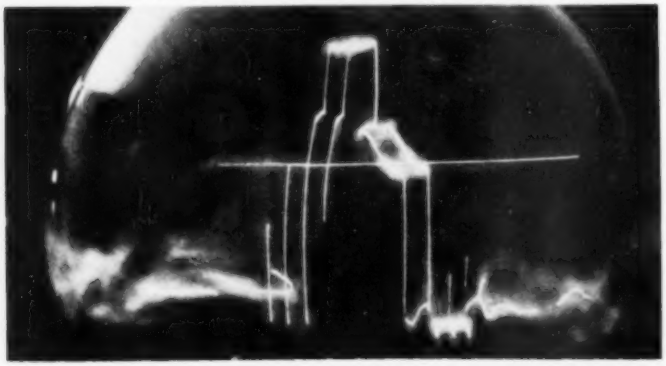


Fig. 5. Normal sync pulse obtained from a receiver aligned to a 2 megacycle bandwidth to permit good video reception in the fringe areas.

Fig. 6. Pulse ghosts as seen on the screen of a receiver operating in a difficult location and caused by multipath transmission. The use of a highly directional antenna frequently improves reception in this case.



forms due to incorrect lead dress or to failing electrolytic condensers which act as a common bypass for two or more circuits.

Vertical Sync Noise Rejection

It is well to observe that the vertical sync circuits are inherently immune to noise because of the long time-constant of the integrator. Noise pulses are relatively narrow, and are rejected by the integrator accordingly.

This is not to say that the vertical sweep oscillator cannot develop sensitivity to noise, and "roll" the picture annoyingly, especially at lower signal levels. This fault can usually be traced to an open condenser in the integrator. Such a condenser cannot be checked satisfactorily with a voltmeter, but shows up definitely on a scope check as distortion of the waveform. The scope also shows the noise pulses coming through the defective integrator, providing the required attenuator pads are used in the antenna line to increase the signal-to-noise ratio.

Faults Due to Alignment

As shown in Fig. 4A, the main body of the sync pulses is developed by the sideband frequencies in the neighborhood of the picture carrier. Misalignment of the receiver can, accordingly, attenuate and distort the sync pulses, as shown in Fig. 4B. If the waveform check indicates that the sync system is not receiving pulses with sufficient peak-to-peak voltage, it is well to make a sweep-alignment check of the overall high-frequency response of the circuits from the antenna posts to the second detector.

It sometimes happens that peak-to-peak voltage specifications are not available for the receiver. In such cases, the service engineer must endeavor to locate the data for some other receiver which uses the same type of sync system, or, he will perhaps be forced to fall back on his own knowledge of circuit operation. Cases like this really test the mettle of the service engineer.

Faults Due to Pulse Ghosts

Failure of a receiver to hold sync, even under relatively high signal-to-noise conditions, has occasionally been observed due to faults in transmission. One of these faults is pulse ghosts, as shown in Figs. 5 and 6. It should be understood that these ghosts can arise from reflection on coaxial cable links, and mismatches in transmission equipment, as well as from the more familiar multipath transmission situation.

Depending upon the number and spacing of the pulse ghosts, as well as upon the type of sync circuits used, mild or severe loss of sync control may result. There is little or nothing that can be done to remedy the situation in the horizontal a.f.c. circuits. However, it is sometimes possible to stabilize the vertical sync by using the power-line voltage for synchronization.

To phase the power-line voltage suitably for vertical sync use, a phasing network as shown in Fig. 7 is usually required. Although this method provides tight vertical sync lock under all conditions, it should be noted that the method fails if the transmitter and receiver do not operate from the same public utility. The frequency and phase relations of different utilities are constantly shifting. As a result, the picture will roll continuously at the difference between the two power-line frequencies.

Noise Gates

If horizontal sync pulses are injected directly into the grid circuit of a blocking oscillator, stable sync action takes place. However, if noise pulses are also present, these cause severe picture tearing. To avoid this difficulty, noise gates are used which minimize the time during which false triggering can occur. In addition, the gate is followed by a delay filter, which operates as a flywheel and further reduces the possibility of false triggering. In some receivers, additional stabilization is provided by a ringing circuit.

A basic gate circuit is shown in Fig. 8. The frequency of the blocking oscillator is controlled, as in other noise-rejection circuits, by the d.c. voltage bias from the control tube. The pulsed output from the control tube must be filtered, as shown, to develop this d.c. bias voltage.

The control tube is cut off during most of the forward trace, so that any noise pulses which may be present will be unable to affect the output of the control tube. When the time approaches for the arrival of the sync pulse, the comparison waveform is nearing its positive peak value; addition of the sync pulse to the comparison wave is now able to bring the control tube out of cut-off, and produce plate-current flow. Noise pulses can also get through the gate at this time.

It is apparent from the diagram that the relative phasing of the sync pulse and the saw-tooth comparison wave determines the width of the control pulse; if the circuit is in proper adjustment, the width of this control pulse is always less than the width of the sync pulse. Consequently, as the horizontal oscillator tends to drift, the control pulse width varies accordingly, which changes the plate-current flow through the control tube.

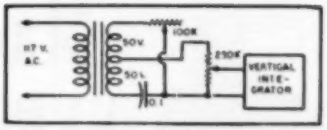


Fig. 7. A phased power line voltage can often be used to stabilize the vertical sync action. Disconnect integrator from the sync separator and energize integrator from a phasable network. Note that the primary terminals must be reversed in some cases.

Not quite all noise pulses are rejected by the gate circuit, because the time of threshold must slightly precede the arrival of the sync pulse in any practical circuit. A saw-tooth or a parabolic comparison waveform is utilized in such systems, so that the grid of the control tube rises rapidly to threshold, thereby minimizing the number of noise pulses which are effective in causing plate-current flow. Noise rejection is maximized, not only by use of an optimum waveform, but also by proper adjustment of cut-off voltage applied to the grid of the control tube.

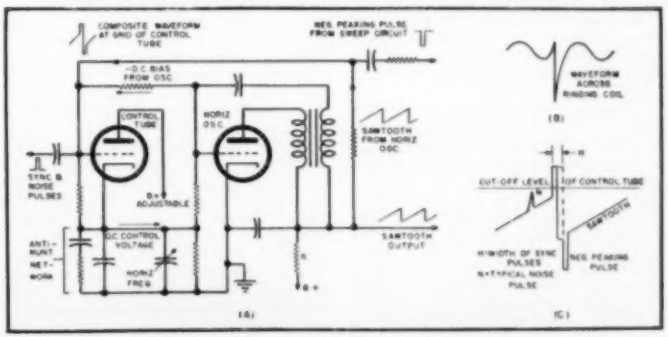
The noise that gets through the gate has the effect of widening the control pulse in a somewhat random manner. However, when circuit adjustments are properly made, the resulting tendency for the horizontal oscillator to increase in frequency will not exceed the lock-in range. The random variation in width of the control pulse is averaged out in the delay filter, so that there is no noticeable horizontal shift of the picture.

As in other noise-rejection circuits, the more obscure causes of instability are often traced to faulty condensers which are not caught in a d.c.-volts or resistance check. Likewise, improper lead dress can cause feedthrough to the horizontal oscillator circuit. A scope check at the grid of the oscillator should show no trace of noise pulses, although the receiver is operating at maximum gain, with no station signal.

A ringing coil is used by some re-

(*Continued on page 162*)

Fig. 8. Immunity to noise depends chiefly on the proper threshold at grid of control tube. The cut-off level is usually adjusted by means of the plate supply voltage. A ringing coil, if used in the circuit, should be inserted at point "B."



Mac's RADIO SERVICE SHOP

By JOHN T. FRYE

SPRING FANCIES

MAC and his office girl, Miss Perkins, stood side by side looking out of the window of the service shop at the ambling figure of Barney coming back to work after his lunch hour. As the youth walked slowly along, his red hair flaming brightly in the April sunshine, his freckled face bore a look of dreamy introspection.

"Ah me," Mac sighed; "what wouldn't I give to be young again in the springtime!"

"Yes," Miss Perkins said with an echoing sigh. "All you need is a look at that rapt expression on his face to know how true are those words about in the spring a young man's fancy lightly turns to thoughts of love."

Barney floated through the door and gradually allowed his eyes to focus on the faces of the other two. Then he spoke in a voice of quiet awe:

"I have just been the recipient of a beautiful thought!"

"Blonde, brunette, or redhead?" Mac inquired solicitously.

"Whatever are you babbling about?" Barney asked with a puzzled frown. "I mean I've just figured out how I'm going to make my first million dollars."

"Thoughts of love," Mac quoted mockingly out of the corner of his mouth to Miss Perkins. "And pray tell us," he continued to Barney, "just how you are going to harvest all this lettuce."

"It's a lead-pipe cinch," Barney answered confidently. "I'm going to write a book entitled '*How to Remove Your Own Appendix, or That of a Friend or Member of Your Family, Using Only a Discarded Razor Blade.*'"

"Hm-m-m-m," Mac said slowly; "I see you like a short snappy title anyway. Where did you get your inspiration for this future best-seller?"

"At the lunch room magazine rack this noon. I was leafing through several of the magazines that try to give popular explanations of various scientific and mechanical achievements, and I ran across quite a few ads for books that promised to tell the television set owner just how he could repair his own television set. Right then I decided that if you could tell a guy who didn't know from nothing about radio or television how he could locate and repair any one of the thousand and one things that can get wrong with a TV set, telling him how to perform a single operation like an appendectomy ought to be duck soup."

"But," Miss Perkins objected, "if the TV instructions are a flop, all the guy will have is a botched-up set; but if your surgical instructions go wrong, he will have a candidate for a harp. That's too dangerous."

"How safe do you think it is to encourage an untrained person to go prowling around in a TV chassis carrying various lethal potentials up to 15,000 volts and better?" Barney demanded. "For years radio magazines have been warning technicians, who are already familiar with high voltage circuits, to be extremely careful to avoid shock in work on television sets; but these books blandly egg the set owner on into wading right into his receiver. Some of them try to protect themselves by saying there is no danger when instructions are followed, but any technician who has had any experience with the ability of untrained people to follow directions in dealing with electronic equipment takes a very dim view of the average person's ability to follow instructions. Look what happens when most people try to take the tubes out of their little a.c.-d.c. sets and put them back the way they were, even when they have a tube diagram to help them."

"You've got a point there," Mac agreed; "but leaving the danger angle entirely out of it, how much help do you think these books would really be to the average owner of a TV set."

"Why they would be a wonderful help," Barney said with a straight face. "They promise to show you how you can repair anything from a shorted picture tube to a set that won't stay in sync in from a few seconds on the comparatively simple jobs to up to five whole minutes on the really tough ones. Just think of that! Why it often takes poor old inefficient me, who never read one of those books, almost five whole minutes to get the back off some of the receivers that use a whole handful of woodscrews to hold it on."

"Guess we'd better buy some of those books and read 'em," Mac suggested wryly.

"We certainly should," Barney blandly agreed. "The fellow who has one of these books needs only a screwdriver to make all of his repairs. There you have gone and wasted better than a thousand dollars on your scopes, sweep generators, vacuum tube voltmeters, bar generators, tube testers, and service manuals. After we have studied these books, we can sell all of that expensive and unnecessary equipment and buy ourselves a nice new screwdriver apiece and really settle down to turning out the TV sets. Since, at the outside, we shall have to spend only five minutes on a set, we'll really make money fast. As it is, we often waste three or four hours running down a tough intermittent or doing a complete job of realignment. Come to think of it, we can let Matilda here read the books, too, and then she can fix sets just as well as you can, for experience is entirely unnecessary, and all of those years that you have spent studying and working on electronic equipment have just been wasted."

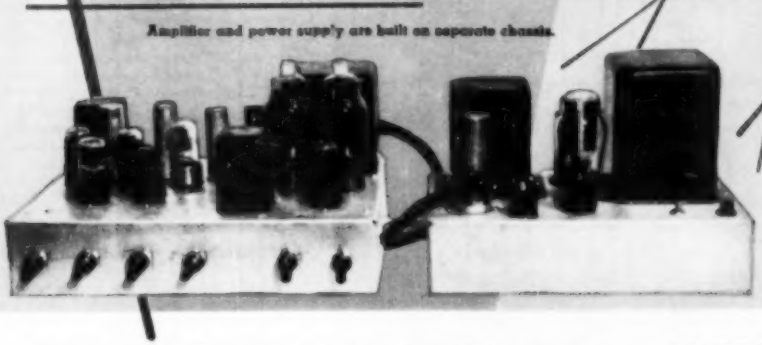
"Tsk, tsk! What a pity!" Mac exclaimed with a broad grin. "Better had we get one of these books at once."

"I'm not sure a technician can buy them," Barney said darkly. "The writers of these books do not trust radio and television technicians. In fact, they encourage the set owner to buy the book so that he can avoid being "soaked" by independent repairmen. I think I'll use that line in advertising my own book. 'Don't let the doctor gouge you for performing a simple operation.' I'll argue; 'buy this book and take out your own appendix. No experience necessary.'"

Miss Perkins looked desperately from Mac's faintly-smiling face to the dead-serious one of Barney. "Mac, how can you stand there and encourage the boy in such a mad idea as writing a book like that?" she de-

(*Continued on page* 164)

A High-Quality AUDITORIUM AMPLIFIER



Amplifier and power supply are built on separate chassis.

By LLOYD B. HUST

Construction data on a p.a. unit which features two mike inputs, radio input, and master mixer.

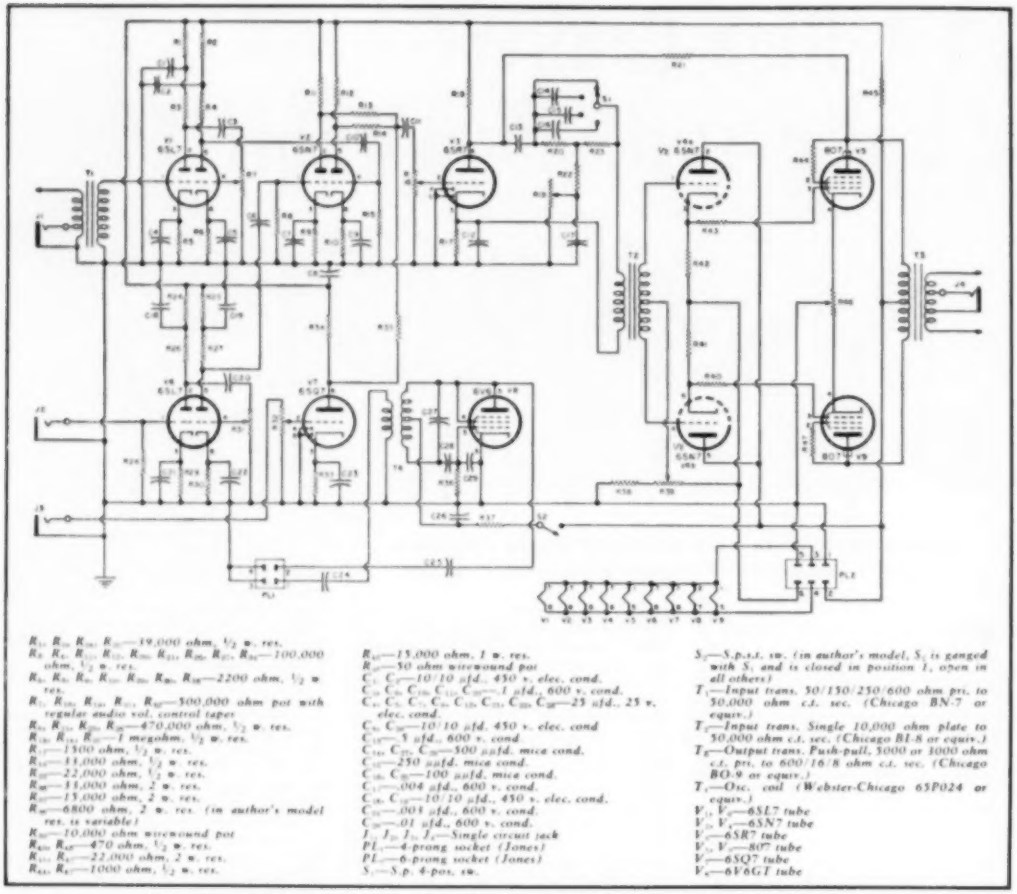
THE great degree of refinement of the audio art which has been attained in the past few years has resulted in a number of so-called "high fidelity" amplifiers. Many of these amplifiers meet the specifications while others are high fidelity in name only. Each designer has his own pet likes and dislikes, and we hear much about the relative merits of pentode tubes *versus* triodes; strict class A operation as opposed to class AB_1 or AB_2; the merits of feedback in an amplifier; flat amplifiers or compensated circuits and so on, *ad infinitum*. However, in spite of the confusion which often arises from such discussions, one can be sure that the real test of an amplifier of any design, be it a unit of high or low power, a circuit of the "o'd standby" type, or one with all the latest frills, is its performance under actual working conditions. Laboratory tests and mathematical theory notwithstanding, the real test of an amplifier is how it *sounds* to the listener in actual operation. A few pains taken in the building of any amplifier, along with the use of high quality components in its construction will usually insure good results, and one does not have to be an engineer to build a really *good* audio system, provided that he takes advantage of the technical information made available to the experimenter by the audio engineer.

The builder should first consider the application of the equipment he plans to build, and that can be a guide in his planning. If moderate power is all that is needed, class A operation of triodes will usually give superb results. On the other hand, higher power requirements will usually necessitate the use of class AB, or class AB_2 design. It should be remembered that triode output tubes are characterized by their low power sensitivity and low plate power efficiency, but when used as class A amplifiers, by their low distortion. On the other hand, pentodes and beam power tetrodes are characterized by their high power sensitivity and plate power efficiency, but they usually have somewhat higher distortion than triodes. If the designer keeps these facts in mind he can build an amplifier of optimum performance in the application for which it is intended.

Since the amplifier described in this article was to be used in an auditorium of moderate size, it was felt that the use of triodes as output tubes would be desirable, providing that sufficient power could be obtained from them. After some experimentation, 807's were chosen as the output tubes. Although these tubes are tetrodes, they can be operated as triodes by connecting the screen grids to the plates. These tubes were chosen instead of 2A3's or 6B4's for two reasons. One reason is that the indirectly heated cathode of the 807, as opposed to the directly heated cathode of the other types, gives less residual hum. The other reason is the greater plate dissipation rating of the 807's. The lower hum level of tubes of the indirectly heated cathode type is especially important if modern high-efficiency speakers are to be used, and the high plate dissipation rating makes it possible to operate these tubes as class A_2 amplifiers, thereby realizing power output in the neighborhood of 30 watts from two of these tubes. Since there are not many amplifiers which operate in this class, a word regarding them is in order here. A class A amplifier is considered to be one in which plate current flows in the output tubes during 360 degrees of the signal current cycle. It is generally concluded that at no time during the cycle will grid current flow. A class A_2 amplifier conforms to these specifications except that grid current flows during a portion of the cycle. However, at no time is plate current cut off. In order to fulfill these conditions, it is necessary to operate the tubes at lower bias voltages than are used for class A or AB, service, and this lower bias, allowing greater no-signal plate current, calls for tubes with relatively high plate dissipation ratings. The May, 1951 issue of the *Radio-Electronic Engineering Edition* of RADIO & TELEVISION NEWS gives typical operating conditions for a pair of these tubes operated as class A_2 triodes.[1]

The amplifier, after considerable experimental work, was finished with the following features: Two microphone inputs, one high impedance and one low impedance; an input for a radio tuner or crystal phono pickup; electronic mixing with a separate control for each channel and a master mixer control. The low impedance input will take input impedances of 50, 150, 250 and 600 ohms, which makes it suitable as an input for any type of low impedance microphone as well as practically any type of line. It is also suitable for low impedance phono pickups or low impedance magnetic tape heads. The *Chicago* BI-7 input transformer used in this channel is of high quality, having a frequency response which is flat within a fraction of a decibel from below 50 to well over 20,000 cycles. This transformer also has 70 db hum

[1] Sterling, Howard T.: "Tube Applications in Amplifier Design," Radio-Electronic Engineering Edition of Radio & Television News, May 1951, page 14A.



R_1, R_{10}, R_{16}, R_{17}—19,000 ohm, ½ w. res.
R_2, R_5, R_{11}, R_{15}, R_{18}, R_{21}, R_{26}, R_{27}, R_{31}—100,000 ohm, ½ w. res.
R_3, R_4, R_6, R_{12}, R_{20}, R_{28}, R_{38}—2200 ohm, ½ w. res.
R_7, R_{13}, R_{19}, R_{23}, R_{29}—500,000 ohm pot with regular audio vol. control taper
R_8, R_{14}, R_{25}—470,000 ohm, ½ w. res.
R_9, R_{24}, R_{30}—1 megohm, ½ w. res.
R_{22}—1500 ohm, ½ w. res.
R_{32}—11,000 ohm, ½ w. res.
R_{33}—22,000 ohm, ½ w. res.
R_{34}—33,000 ohm, 2 w. res.
R_{35}—15,000 ohm, 2 w. res.
R_{37}—6800 ohm, 2 w. res. (in author's model res. is variable)
R_{39}—10,000 ohm wirewound pot
R_{40}, R_{42}—470 ohm, ½ w. res.
R_{41}, R_{43}—22,000 ohm, 2 w. res.
R_{44}, R_{45}—1000 ohm, ½ w. res.
R_{46}—15,000 ohm, 1 w. res.
R_{47}—50 ohm wirewound pot
C_1, C_{27}—10/10 µfd., 450 v. elec. cond.
C_2, C_3, C_{11}, C_{22}—.1 µfd., 600 v. cond.
C_4, C_5, C_7, C_8, C_{12}, C_{23}, C_{28}—25 µfd., 25 v. elec. cond.
C_6, C_{26}—10/10 µfd. 450 v. elec. cond
C_{10}—5 µfd., 600 v. cond.
C_{13}, C_{20}, C_{30}—500 µµfd. mica cond.
C_{14}—250 µµfd. mica cond.
C_{15}, C_{21}—100 µµfd. mica cond.
C_{17}—.004 µfd., 600 v. cond.
C_{18}, C_{19}—10/10 µfd., 450 v. elec. cond.
C_{24}—.003 µfd., 600 v. cond.
C_{25}—.01 µfd., 600 v. cond.
J_1, J_2, J_3—Single circuit jack
PL_1—4-prong socket (Jones)
PL_2—6-prong socket (Jones)
S_1—S.p. 4-pos. sw.
S_2—S.p.s.t. sw. (in author's model, S_2 is ganged with S_1 and is closed in position 1, open in all others)
T_1—Input trans. 50/150/250/600 ohm pri. to 50,000 ohm c.t. sec. (Chicago BN-7 or equiv.)
T_2—Input trans. Single 10,000 ohm plate to 50,000 ohm c.t. sec. (Chicago B1-8 or equiv.)
T_3—Output trans. Push-pull, 5000 or 3000 ohm c.t. pri. to 600/16/8 ohm c.t. sec. (Chicago BO-9 or equiv.)
T_4—Osc. coil (Webster-Chicago 65P024 or equiv.)
V_1, V_2—6SL7 tube
V_3, V_4—6SN7 tube
V_5—6SR7 tube
V_6, V_7—807 tube
V_8—6SQ7 tube
V_9—6V6GT tube

Circuit diagram and parts list covering the auditorium amplifier. 807's are used, connected as triodes.

reduction, due to its excellent shielded construction, which makes it ideally suited to this type of application.

The high impedance channel was designed for use with standard high impedance type microphones, but it has sufficient gain to be used with a high impedance tape recording head if desired. The mixing action of this channel with the low impedance channel and with the phono channel is very smooth and operates without a trace of interaction between channels.

The phono channel has sufficient gain for use with any of the many types of crystal phono pickups, and it is especially suited to operate from a radio tuner, either AM or FM. The master mixer control which follows these three channels makes it possible to increase or decrease the volume of the amplifier without disturbing the relative volume levels of the various channels. This feature makes for easy volume adjustment, even though all channels are in use simultaneously.

As seen in the photographs, the amplifier and power supply are built on separate chassis, the amplifier chassis measuring 14" x 10" x 3", while the power supply chassis dimensions are 7" x 12" x 3". The two units are connected by a cable with a 6-prong *Jones* plug on each end. The power supply and amplifier are supplied with corresponding plugs to make power supply connection or disconnection extremely simple. This two-unit type of construction has several advantages of which perhaps the greatest, is that of hum reduction because of the degree of isolation of the power transformer and the amplifier proper. Another value of a separate power supply is apparent to the builder who does considerable experimental work—one power supply can perform for several experimental jobs.

The two high gain channels of the amplifier each utilize the two sections of a 6SL7 tube connected in cascade. The volume control for each channel is in the second stage. The output from the second section of each 6SL7 is fed into a section of a 6SN7, the output of which is fed to the master mixer control. The output of the 6SQ7 phono amplifier is also fed to this control. R_{44}, R_{45}, and R_{46} are 1 megohm resistors which are used to isolate the plates of the tubes feeding this control. The master mixer control, R_{47}, controls the signal fed to the grid of the 6SR7 tube, from whence the signal is fed, either directly or through the equalizing circuit, to the 6SN7 driver tube.

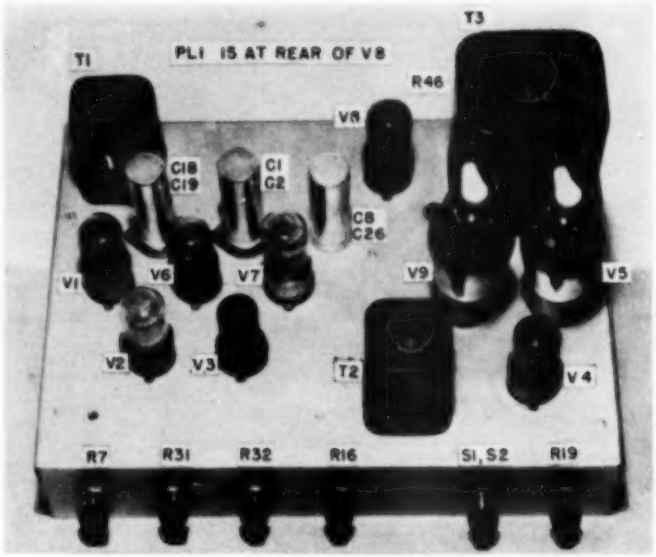
Several hum prevention measures are used in the construction of this unit. The center tap of the filament winding of the power transformer is grounded. In the model shown, this proved adequate as far as heater-to-cathode hum is concerned, but in some models it may be necessary to use a 20 ohm potentiometer across the 6.3 volt winding and ground the center. In this way, a precise balancing-out of hum can be achieved. Only one connection is made to the chassis proper—at the socket of the tube V_9. All other grounds are made to a ground bus which is

made of No. 12 wire mounted on insulated tie posts. This bus can be seen in the photograph of the under chassis view. It is grounded to the chassis as indicated before. All jacks, condenser mounts, etc., are insulated from the chassis to eliminate any possibility of ground loops. There are two or three relatively long grid leads in the amplifier, and these are shielded, but the shielding is not allowed to touch the chassis, and *one end only* is grounded to the ground bus. Some of these precautions may seem needless to the uninitiated, but they pay off in the hum-free operation of the amplifier. It should be said in the discussion of hum precautions that at first, d.c. operation of preamplifier tubes was contemplated, but it was found that in addition to the measures taken as mentioned above, the twisting of all a.c. leads, and dressing them close to the chassis, made the use of d.c. on the heaters unnecessary.

It is the opinion of the author that any really up-to-date amplifier should have provision for magnetic tape recording and playback, and accordingly, this unit is provided with an ultrasonic oscillator to adapt it to this purpose. The oscillator tube is a 6V6GT connected as a triode, and it supplies ultrasonic voltages for both high and low impedance recording heads, as well as erase heads. When the waveform of this voltage was checked on an oscilloscope, a good sine wave, necessary in distortionless recording, was observed. The output of the oscillator is fed to a 4-prong *Jones* socket through condensers C_{14} and C_{15}. Since the sizes of these condensers vary somewhat according to the recording heads used, their values may have to be adjusted to suit the particular head used. The values shown work nicely with the *Shure* Model 815 head, the connection from the plate of the oscillator tube going to the high impedance winding of the head, and the connection from the secondary of the oscillator coil furnishing the voltage for the erase section of the head.

For the oscillator circuit a *Webster-Chicago* oscillator coil (65P024) is used. Other oscillator coils designed for magnetic tape or wire recorders can be used, but the values of the other components in the oscillator circuit may have to be changed to suit the characteristics of the particular coil used. In most cases the maker of the oscillator coil furnishes the necessary data with the coil. The oscillator operates best with 250 to 275 volts on the plate of the tube and some adjustment in the size of R_{31} may be necessary to assure the correct voltage here. This resistor aids in keeping the high frequency oscillations of the 6V6 out of the power supply as well as performing its function as dropping resistor in the plate circuit of the oscillator.

The original design and tests of the amplifier were made by striving for a flat response. However, to make the unit suitable for magnetic recording and for other applications in which equalization is required, a number of

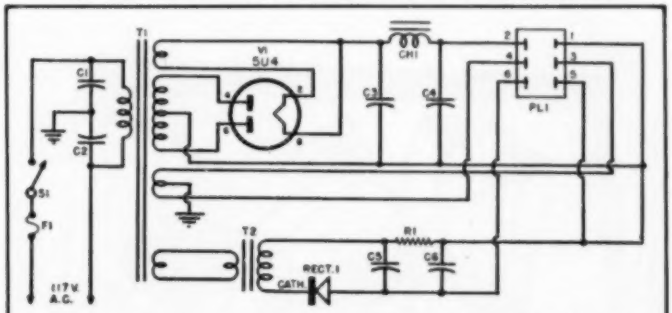


Top view of the amplifier chassis. Careful parts layout facilitates servicing.

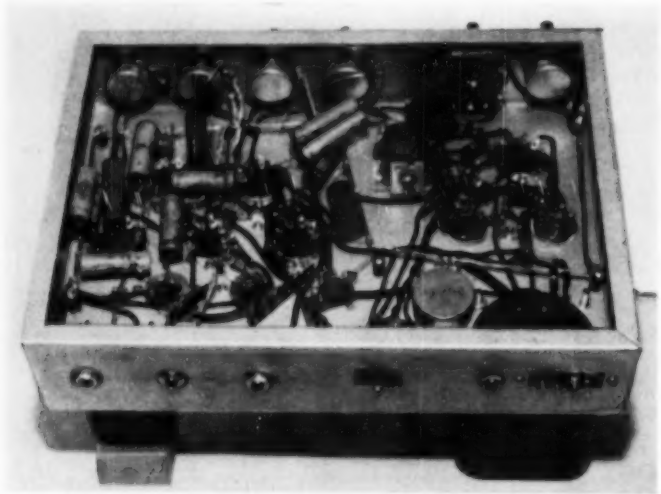
equalizing circuits are arranged so that they can be switched into the circuit. The equalizing portion of the amplifier consists of R_{28}, R_{29}, R_{30} and R_{33}; C_{13}, C_{16}, C_{18}, and C_{17} along with S_3. S_3 switches in a bridged-"T" equalizing network which gives some attenuation of the middle frequencies, which, in effect, gives high and low boost to the signal. Switch position 1 gives the greatest attenuation with positions 2 and 3 giving lesser degrees, while position 4 short circuits the equalizing network and, in effect, removes it from the circuit. The action of R_{28} is to give variable attenuation to the bass portion of the signal in the first three positions of the switch. In the fourth position, R_{28} has no effect. R_{28} should be placed in the treble position—all resistance out of the circuit—for magnetic recording, and it should be placed in the bass position—maximum resistance in the circuit—for playback of magnetic recordings. The switch S_4 removes the plate voltage from the oscillator tube when the oscillator is not desired. In the author's model, this switch (S_4) is one section of S_3 and is closed in positions 1 and 2 of S_3. However, it is recommended that a separate switch be used for this purpose so that the oscillator can be cut in or out regardless of the position of the equalizing switch.

It is obvious that if the builder is not interested in the adaptation of this am-

Power supply circuit and parts list. This unit is mounted on separate chassis.



R_1—3000 ohm, 2 w. res. (in author's model res. is variable)
C_1, C_7—.1 μfd., 600 v. cond.
C_3, C_4—40/40 μfd., 300 v. elec. cond.
C_5, C_6—40/40 μfd., 150 v. elec. cond.
F_1—3 amp. fuse
S_1—S.p.s.t. sw.
T_1—Power trans. 385-0-385 v. a.c. sec. @ 200 ma., 5.0 v. @ 3.0 a., 6.3 v. @ 4.3 a., 6.3 v. @ 1.0 a. (Chicago PSC 200 or equiv.)
T_2—Bias supply trans. 105/125 v. pri., 6.3 v. c.t. @ 3.0 a. sec. (Chicago FO-63 or equiv.)
CH.—Filter choke, 12 hy., 200 ma. (Chicago RS-12200 or equiv.)
Rect.—100 or 150 ma. selenium rectifier
PL.—6-prong socket (Jones)
V.—5U4G tube



Bottom view of the amplifier. Easily-obtainable parts have been used throughout.

plifier to magnetic recording, the oscillator and equalizing circuits can be eliminated and a somewhat simpler amplifier will result. However, the addition of these circuits does not introduce any great problems and they will be of use in many installations. Either high or low impedance magnetic recording heads can be used. If a high impedance head is used, the audio voltage can be taken from the plate of one of the output tubes, while a low impedance head can take its audio signal directly from an appropriate tap on the output transformer.

Some discussion of the output stage and associated driver is in order as the operation of the output stage is not conventional. In order to operate the output tubes class A_1, the following operating conditions prevail: Plate voltage, 400; grid voltage —35; driving voltage 50; plate-to-plate load 3000 ohms; zero signal plate current (both tubes) 140 ma., max.; and signal plate current 215 ma. Maximum signal instantaneous grid current is 20 milliamperes.

Since grid current flows during part of the cycle, it is necessary to design the driver stage so that distortion will not result. One consideration is that the driver stage must be capable of supplying some power to the grids of the output tubes. The use of a driver transformer of proper design could provide this, but since the windings of the transformer would have to carry considerable current, the frequency response would suffer. A cathode follower driver tube is capable of supplying considerable power to the driven stage, and it has several other advantages, not the least of which is a practically flat response. For this reason, a 6SN7 tube operated as a cathode follower was used as the driver. The circuit selected is one which has been used successfully in other high-quality amplifiers, and it can be considered tried and true. Fixed bias is used on the driver stage as well as on the output stage, the voltage drop through the cathode resistors of the driver bringing the output stage bias to the right value. R_m is the bias control, and it should be adjusted so that the voltage at each grid of the 807's is 35. This can be done if the total bias voltage supply is in the neighborhood of 105 volts. The use of the recommended values of resistors R_m and R_s will insure this condition.

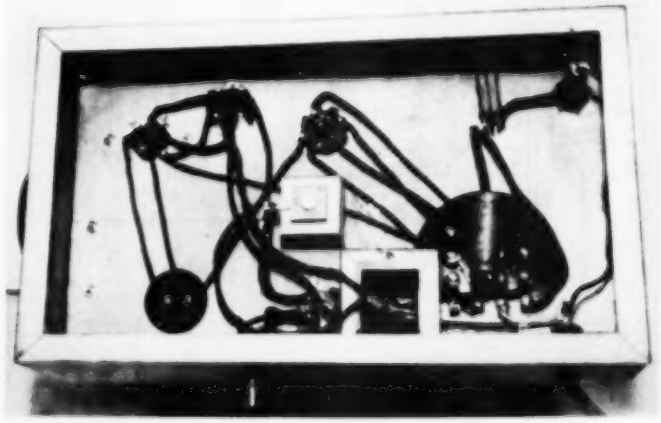
A phase inverter could be used to supply the signal to the driver stage, but since practically every type of phase inverter has some fault, a high quality transformer was chosen to supply the driver grids. The *Chicago* BI-8 input transformer was selected because of its wide range flat response. Since this transformer must not be used with direct current in the primary if this wide range response is to be maintained, it is coupled to the plate of the previous tube by the use of a .5 mfd. condenser. This arrangement insures that a balanced voltage, exactly 180 degrees out-of-phase, is supplied to the two grids of the cathode follower. The plate voltage of the tube feeding this transformer is supplied through a 33,000 ohm plate load resistor.

The power supply of this amplifier is built on a separate chassis which can be mounted above or below or to one side of the amplifier proper. The *Chicago* PSC-200 power transformer and RS-12200 choke are used as companion units for the plate supply, while the bias supply is provided by a small filament transformer—the *Chicago* FO-63. This transformer is connected "backwards" to supply the necessary bias voltage. That is, its 6.3 volt winding is connected to the extra filament winding on the power transformer so that the original primary delivers in the neighborhood of 120 volts. This is connected through a 100 or 150 ma. selenium rectifier to a filter system consisting of a 40-40 mfd., 150 volt filter condenser and a 3000 ohm, 2 watt resistor. This combination will give the correct bias voltage for the output and driver stages. The author considered using a voltage regulator tube with this bias supply, but experiments with the amplifier under load indicated that it was not necessary. The use of a selenium rectifier in the bias supply has the advantage that there is no "warm up" period for the bias supply, and bias is supplied to the tubes before the plate voltage, which is a protective feature.

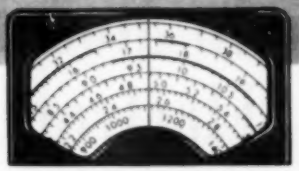
The filter condensers of the plate supply are 500 volt condensers with 40 mfd. in each section. This high voltage rating is necessary because of the possibility of high surge voltages. These condensers, in conjunction with the RS-12200 choke, supply well filtered volt-

(*Continued on page* 149)

Under chassis view of the power supply. This unit measures 7x12x3 inches.



International SHORT-WAVE



***Compiled by* KENNETH R. BOORD**

AT THE time this was compiled, the Broadcasting Corporation of Japan, Tokyo, had just resumed (test) operations of its Overseas Services in Japanese and *English*. A letter received from the station's officials pointed out:

"The Broadcasting Corporation of Japan has resumed operation of its international broadcasts in both *English* and Japanese languages. The purpose of this international broadcast is to tell the world the actual condition of Japan and how the country is being rehabilitated with the kind help and cooperation of friendly nations; and how the people are willing to do what they can for the promotion of a better understanding among the nations of the world. Listeners overseas are, therefore, cordially requested to send their reports of reception of our station, giving us at the same time their candid opinions as to the kind of programs they want to be sent on the air. All mail should be addressed to International Broadcasting Section, Nippon Hoso Kyokai (The Broadcasting Corporation of Japan), Tokyo, Japan."

General format for the various beams includes opening announcement; news in *English*; commentary in *English*; music; news in Japanese; commentary in Japanese; closing announcement; closedown.

Schedules were listed: *Transmission* 1—To North America 0000-0100, JOB, 6.069; *Transmission* 2—To North China 0600-0700, JOB, 6.069, and JOA, 7.180; *Transmission* 3—To Central China 0700-0800, JOB and JOA; *Transmission* 4—To Philippines and Indonesia 0900-1000, JOB-2, 11.705, and JOA-2, 9.675; *Transmission* 5—To India 1030-1130, JOB-2 and JOA-2.

The test transmissions have been widely heard throughout the United States. It is reported by overseas sources that the International Service is being beamed from two 50 kw. transmitters—one at Yamata and one at Nazaki.

Our best wishes go to the Broadcasting Corporation of Japan for the future expansion of its International Service.

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Radio Club Notes

England—The first postwar meeting of the World Friendship Society of Radio Amateurs was held recently in London. It was decided that an annual meeting of the group will be held hereafter. The Mullard Organization presented a display of its cathode-ray tubes, radio tubes, and the projection system of TV developed by Mullard. A high point of interest was the presentation of a book-token to Miss Barbara Jordan, a member of a School Radio Club at the Guilford Girls' School in Nottingham. The book-token was given as a mark of the Society's esteem for Barbara's achievement in passing the G.P.O. c.w. test at 12 w.p.m. at 14 years of age. She is thus the youngest girl in the British Isles to have achieved this distinction, officials of the club point out. Barbara is now authorized to operate the School Club Station, G3FYN, and to operate at station G2ATM (operated by Stan Read, the science teacher at the Guilford Girls' School), under supervision. Young people anywhere in the world who are interested in the activities of WFSRA's Junior Section, should get in touch with Bob Kenny, G3AAU, at 30, Churchbury Road, Enfield, Middlesex, England.

(Note: Unless otherwise indicated, all time is expressed in American EST; add 5 hours for G.M.T. "News" refers to newscasts in the English language. In order to avoid confusion, the 24 hour clock has been used in designating the times of broadcasts. The hours from midnight until noon are shown as 0000 to 1200 while from 1 p.m. to midnight are shown as 1300 to 2400.)

The symbol "V" following a listed frequency indicates "varying." The station may operate either above or below the frequency given. "A" means frequency is approximate.

Norway—A new short-wave listeners' club is Arctic Listeners Club, Tromso, Norway, according to *Nattugglan*, Sweden.

USA—Anyone wishing information about the United Shortwave Listeners of the World should write direct to the club's editor, Steve Brookner, 85 Glenham Street, Providence 7, Rhode Island. President of this organization is Hal Buchert; treasurer is Pat Crandell.

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This Month's Schedules

(*NOTE:* By the time you read this, some short-wave stations may have gone on Summer Time Schedules; in such cases, you may find broadcasts are now *one hour earlier* than listed herein.—KRB)

Afghanistan — Peter Ridgeway, South Africa, flashes that *Radio Kabul*, 9.975, now has its daily *English* session 1110-1120; opens with flute-like instrument around 1105; closes with one request number at 1120, *except* Sundays when extends the request period to 1200A.

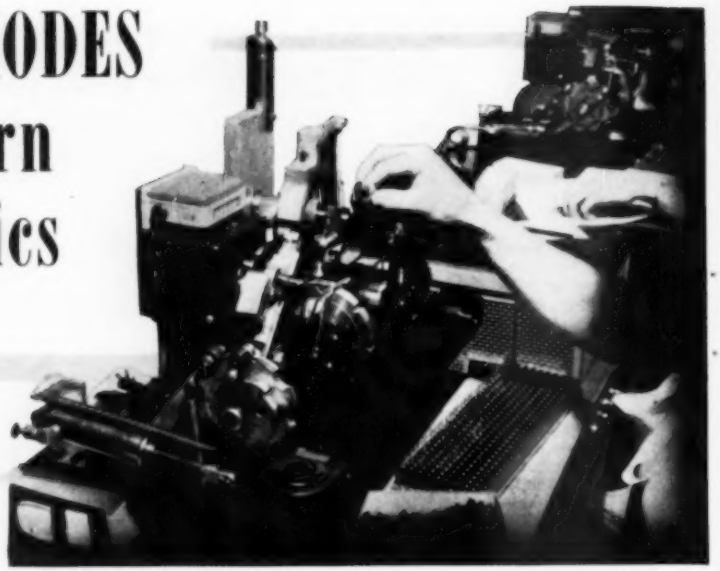
Albania — *Radio Tirana*, 7.852A, noted signing off 1629 with march; weak level. (Robbins, Ind.) Has news 1615. (Ridgeway, South Africa)

Algeria—*GDX-aren*, Sweden, lists

(*Continued on page* 112)

This young SWL is Ronald Guentsler, Cleveland, Ohio. Equipment shown includes a Zenith 10-S-155; preselector and converter for Zenith unit (preselector operates 7-18 mc. and converter covers 200-540 kc.). Hallicrafters S-41-G, BC-454-B, and BC-455-B.

CRYSTAL DIODES In Modern Electronics



Whisker and pellet assemblies are mounted in plastic cases on this specially-designed high-speed assembly machine. The whisker point is welded to the germanium pellet and very accurate pressure maintained between these two parts. Following this, and on same machine, the units are electrically formed by high current pulses.

By
DAVID T. ARMSTRONG

Part 7. How germanium diodes can be used in TV circuits to perform the sync stripping function.

OBVIOUSLY before the control impulses in the composite video signal can be used for synchronizing purposes they must be stripped from the remainder of the video and blanking information. This is essential to prevent these other signals from interfering with the sync circuits. Sync stripping may be performed in several ways; by using a diode in the form of a detector, by using a triode operating with low plate voltage and high grid resistance, and by using a pentode with low plate voltage and grid bias. We are concerned here only with the use of a diode sync stripper because this is the only method strictly applicable to germanium crystal diodes.

The point at which the composite video signal is taken for application to the clipper circuit is generally the output of the video amplifier. By permitting the composite video signal to come through the video amplifier before applying it to the clipper, there is less need for amplification of the sync pulse after the clipper action. Further, where noise limiting is employed in the video amplifier, and this is generally true, more stabilized and less distorted signal is available for sync. It is possible to amplify the signal after the clipper action; this is done in some receivers, but it does add to the cost of the completed product.

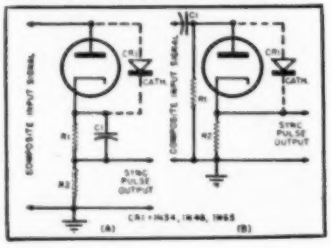
Basic Crystal Diode Circuit

The composite signal furnished to the stripper circuit may be obtained from the video detector or from any stage of the video amplifier. It is common to take it from the output of the video amplifier because a high amplitude signal with good signal-to-noise ratio is available there. Generally, the sync will be good when the contrast control is correctly adjusted for proper picture presentation.

Let us assume we have a source of positive-going composite video signal. Fig. 1A illustrates a basic diode circuit used for stripping; note that this is in the form of a detector circuit. The time constant of R_1-C_1 is sufficiently large so that only the sync pulses cause diode current to flow. The direct current develops sufficient bias voltage across R_1 to prevent stripping any video information from the composite video signal below the blanking level.

The pulse current flows through R_2 and the stripped pulse voltage may be taken off across this resistor. This stripper should be driven from some constant source because any change in the input voltage may result in a change in the voltage across C_1. The long time constant of R_1-C_1 may cause *loss* of the sync pulse until the clipping level adjusts to the proper voltage value.

Fig. 1. (A) Basic biased diode clipper. The time constant of R_1-C_1 should be large. Either a tube type diode or a crystal type diode may be used in this circuit. (B) Basic diode type clipper. The time constant of R_1-C_1 should be long compared to time of the line scan. It is frequently 200 to 300 microseconds. Either a tube or crystal diode is used as the detector element.



Before we proceed further with the analysis of the use of a germanium diode for this type circuit to see how it would fit in, the reader is warned that a pentode cascade circuit is superior in all respects to a cascade germanium crystal circuit. But there are some advantages in using the germanium diode which make it quite worth while to consider.

To obtain reliable synchronization over the wide range of signals at the sync input and to produce clear-cut separation of all video components below the separation level, regardless of amplitude or phase of the video signal, usually requires three vacuum tubes. It requires three germanium diodes to provide comparable performance. Hence, the chief virtue of the germanium diode sync separator is the saving in tubes and components, plus space economy.

Circuit simplification is the order of the day; any reduction in the number of tubes on a chassis makes possible the designer's dream of smaller and more compact television receivers. The use of a diode high level separator connected by suitable coupling methods to the plate of the last video amplifier

stage is one method of reducing the number of tubes on a chassis.

Sync Separation

There are several methods of separating the sync signals from the composite video signal. Fundamentally, this is generally accomplished by applying the composite video signal to a diode, triode, or pentode, so biased that no signal flows through the tube except for that part of the entire signal above the blanking level. This means that a clipper diode will be operated with a negative bias of sufficient value that current will flow through the diode only during the time that the signal is above the blanking level. This is illustrated in Fig. 1B, which shows another type of biased diode clipper arrangement, in addition to that shown in Fig. 1A.

In this circuit the positive-going input signals permit current to flow only for a portion of the input signal; therefore the plate current consists only of sync pulses free from the actual picture information. The biased diode methods of sync separation shown in Figs. 1A, 1B are the simplest clipper circuits. The diode conducts when the input signal is positive and the time constant of R_1-C_1 is sufficiently great to keep the diode from conducting except during the peaks above the blanking pedestal. The diode current drawn charges the condenser to the peak value of the input signal and establishes a bias across condenser C_1. This bias is sufficient to keep the diode from conducting except during the peak excursions of the composite video input signal. The excursion of the signal from the video intelligence level to the peak sync level is the essential line timing operation which synchronizes the horizontal oscillator in the receiver.

When the diode does conduct a voltage appears across R_2 proportional to the sync pulses. The values of R_1 and C_1 are chosen to prevent diode current from flowing except during the interval when the signal is in excess of the blanking level. In general this is a satisfactory signal clipper, but the output sync signal is relatively small because a diode contributes no amplification to the clipped sync pulse.

One disadvantage of the tube type diode clipper circuit is that some video signal may be coupled to the output circuit by virtue of the cathode-plate capacitance of the tube, usually 3 to 4 $\mu\mu$fd., for the 6H6 and 6AL5 type tubes. This is one instance in which a germanium diode crystal has a decided advantage. On the other hand since a diode conducts only during the peaks of the sync pulses it acts as a clamper (a clamping circuit is one in which the amplitude of a waveform is maintained at a certain potential level) and the peak of each recurring sync pulse is lined up at the same level.

In the clipper diode circuit shown in Fig. 1B the time constant of C_1 and R_1 maintains a high average bias between the plate and the cathode. The condenser C_1 is charged to the peak value of the input signal during the peak excursions of the input signal. If the time constant is of the proper value, a high average bias will be maintained between the plate and the cathode and the only time during which current will flow through R_2 is during the time that the input signal is above the 75% blanking level.

Combination Circuits

In some instances it is possible to combine the functions of sync separator and d.c. restorer in a single crystal diode component. Fig. 2 presents such a circuit for the consideration of those interested in simplification. Another crystal may be added to this circuit to perform the function of clipper, as shown in Fig. 3.

The germanium diode CR_1 is the sync separator-d.c. restorer diode. The one megohm resistor is the normal diode load resistor and the 0.05 μfd. condenser the coupling condenser. The resistor in series with the anode of the germanium crystal and the CRT bias is the impedance across which the sync signals are developed. The operation of this circuit depends largely upon the value selected for resistor R_1. Sync pulse output, video leakage, and reinserted d.c. are affected by the size of this component. Values from 4700 to 10,000 may be used depending upon how much video leakage can be tolerated, how much departure from ideal d.c. restoration is permissible, and how much sync pulse amplitude is required.

The circuit action for this diode circuit is as follows: The composite video signal at the cathode of the crystal CR_1 causes rectification and this sets up a voltage across the 1 megohm load resistor, approximating the blanking level. During the line scanning interval the 0.05 μfd. condenser discharges partially through the 1 megohm resistor to maintain the blanking level. At the end of the line scan the condenser recharges rapidly during the sync pulse, and a pulse of current (corresponding to the sync pulse) flows through the resistor in series with the anode of the germanium crystal and the CRT bias. It is the voltage corresponding to this current pulse which may be used as the sync signal.

Zero diode capacitance would be a gift from the gods at this point, because the small (nominally 2 $\mu\mu$fd.) capacitance of the germanium diode permits a vestige of the video signal to appear at the sync pulse output whenever the video modulation frequency exceeds 0.5 mc. The clipper diode, CR_2 of Fig. 3, in conjunction with the 4700 ohm resistor is a shunt limiter of the type discussed earlier in this series, under AM and a.v.c. This shunt type limiter helps remove jitter resulting from video leakage that appears on the sync pulse base line.

The combination sync separator-d.c. restorer circuit shown in Fig. 2 is undesirable without the limiter shown in Fig. 3 because this helps eliminate sync variability and unevenness. The circuit may be improved by the use of a limiting sync amplifier circuit, as an adjunct to this germanium diode circuit; this is shown in Fig. 4.

Variability in blanking level appears

(*Continued on page 117*)

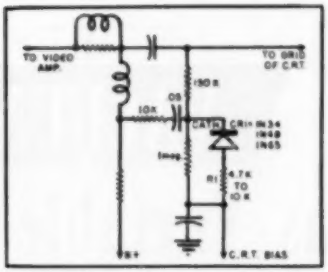


Fig. 2. Combination sync separator and d.c. restorer. This circuit is especially suitable for compact, moderately-priced sets.

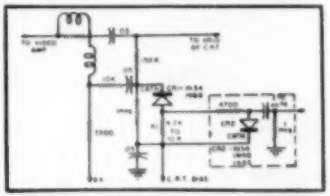


Fig. 3. Combination sync separator, d.c. restorer, and clipper diode circuit. Clipper diode is shown in the dotted line section.

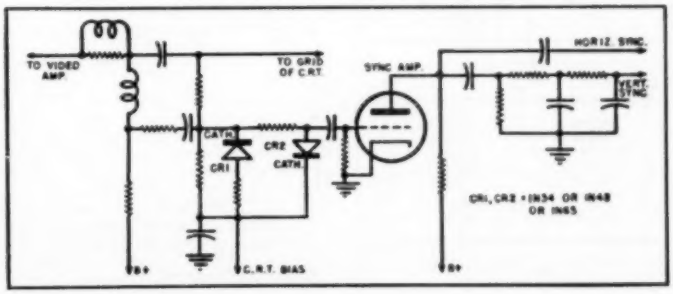


Fig. 4. Germanium diode sync separator and sync clipper with sync auxiliary circuit. This is an idealized version of the circuits shown in Figs. 2 and 3 as it eliminates the defects of those circuits and introduces no new circuit faults.

VACUUM TUBES as Variable Resistance Circuit Elements

By

WAYNE B. DENNY

Physics Dept., Grinnell College

How vacuum tubes can be used as volume or tone controls in place of ordinary variable resistances. Article also covers v.d. applications in expander and compresser circuitry.

THE use of vacuum tube circuits to simulate variable capacitances and variable inductances is common practice in many branches of electronics. Variable reactance tube circuits find application in frequency modulation systems, automatic frequency control systems, the *Scott* type of dynamic noise suppressor, and elsewhere. In these applications the effective plate-to-cathode reactance depends upon the grid-to-cathode voltage.

But a.c. circuits contain resistance as well as inductance and capacitance. The dynamic plate-to-cathode resistance of vacuum tubes can be used as a circuit element and this resistance is easily varied between rather wide limits by the application of suitable grid-to-cathode voltages. Minimum values of R_p are normally obtained with zero potential difference between grid and cathode. Maximum values of R_p occur when the negative grid voltage approaches cut-off, in which case R_p approaches infinity. This is clearly seen by inspection of the plate characteristics for triodes. (See Fig. 2.) The value of R_p at any point is the reciprocal of the slope of the constant grid voltage line through that point. The plate resistance is defined as

$$R_p = \frac{\delta V_p}{\delta I_p} = \frac{\Delta V_p}{\Delta I_p}, \quad E_c = \text{constant}$$

It will be noted that for the usual triode, R_p has its minimum values in the upper left-hand portions of the characteristics while the maximum values occur nearer the bottom and toward the right.

The criteria for proper use of the plate resistance of a vacuum tube as a variable circuit element are: (1) R_p should change smoothly from minimum to maximum with increasing values of negative grid potential; and (2) R_p should be independent of normally expected plate voltage fluctuations. The first criterion requires no comment. The second requires that the constant grid voltage lines should be straight (though not parallel) in that region of the characteristics over which operation is normally expected. This criterion cannot be completely satisfied because the constant grid voltage lines approximate a three-halves power law. Thus the linearity requirements are similar to those assumed for the so-called "small signal analysis" of vacuum tube circuits generally. For large signals the variation of R_p with variations in plate voltage may or may not be detrimental depending upon the application.

Applications

In Fig. 1A variations of e_c are used to control the gain of a voltage amplifier. In this circuit R_1 and the plate resistance R_p of V_1 comprise a voltage divider connected between the plate of V_1 and ground. If R_2 is large compared to R_1 and the plate resistance of V_1, the effective load-line for V_1 is the line R_2 of Fig. 2. Strictly speaking, this is the load-line only when the signal voltage is zero. When a signal is impressed the operating point fluctuates along one of the constant grid voltage lines. It is more correct, therefore, to speak of the *effective load region*. In Fig. 2 the effective load region is bounded by the dotted lines parallel to and equidistant from the no-signal load-line, R_2. The positions of the intercepts of these two dotted lines correspond to a signal voltage at the plate of V_1 whose peak value is ΔV_p. If e_c is variable between zero and cut-off, maximum attenuation occurs when e_c is zero.

$$\frac{e_{out}}{e_{in}} = \frac{(\text{gain of } V_1) \times R_{p\ min}}{R_2 + R_{p\ min}}$$

Minimum attenuation occurs when the operating point is shifted to cut-off. With a finite load resistance connected across the output of the circuit the minimum attenuation is never zero; the larger the load resistance the less

Fig. 1.

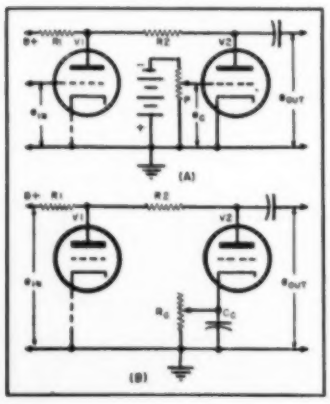


Fig. 2.

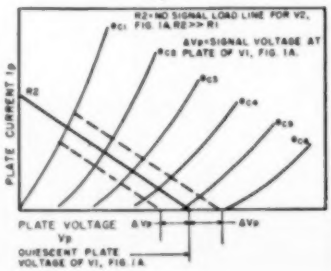
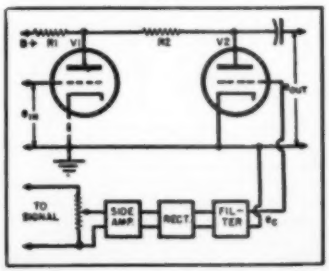

R2=NO SIGNAL LOAD LINE FOR V2, FIG. 1A. R2 >> R1
ΔVp=SIGNAL VOLTAGE AT PLATE OF V1, FIG. 1A.
PLATE CURRENT Ip
PLATE VOLTAGE
Vp
QUIESCENT PLATE VOLTAGE OF V1, FIG. 1A.

Fig. 3.



is the minimum attenuation. This circuit is useful because potentiometer P can be located at a remote point: no signal currents are carried by P. A more practical circuit is shown in Fig. 1B. Here the grid voltage for V_1 is developed across the variable cathode resistance R_c. The function of C_c is threefold: (1) it places the cathode of V_1 at ground potential for a.c.; (2) it helps to satisfy the second criterion by making the grid voltage independent of the instantaneous plate potential; and (3) it removes signal currents from R_c which is required when this control is remotely located.

One disadvantage of this circuit is its inability to reduce the output voltage to zero. However, it is suitable when gain reductions on the order of 20 to 25 db are sufficient. One obvious application for custom audio installations is a remote volume control located near the telephone or a favorite listening position. In this and similar applications the circuit is definitely superior to the use of a variable-mu tube with remotely located variable cathode resistor. The latter arrangement, although employed in some commercial equipment, contributes a high order of distortion unless the signal voltages are very small. This occurs because of the curvature of the variable-mu characteristic. By comparison, the resistance tube attenuator is practically distortion-free provided the second criterion is satisfied as it will be for signal voltages less than 10 volts or so.

Volume Expansion and Compression. When the control voltage e_c is derived from the signal to be amplified there results an extremely efficient volume expander or compressor. As shown in Fig. 3, the signal voltage is amplified by the side amplifier, rectified, filtered, and then the control voltage is fed to the grid of the variable resistance tube. For expansion the signal is picked off ahead of the resistance tube: for compression the signal is picked off behind the resistance tube to avoid possible inversion of the dynamic relations of the signal.

If the time constants of the filters of Fig. 3 are short, the control voltage, after amplification by the resistance tube, will appear in the expanded or compressed signal. This amplified control may exceed the desired signal with consequent overloading of subsequent amplifier stages. The circuit of Fig. 4 avoids this possibility by the use of a push-pull arrangement. The push-pull cathode followers are practical proof against overloading caused by extraneous control voltages at the plates of the resistance tubes. Further, the cathode followers isolate the primary of the transformer from the variable generator resistance offered by the resistance tubes. All control voltages cancel in the transformer. The writer has built several expander-compressors using this arrangement. The time constant can be as short as a few milliseconds without transient distortion.

Dynamic Noise Suppression. In the circuit of Fig. 5 the variable resistance tube and C comprise a low-pass type of tone control. When the grid voltage of the control is zero the plate resistance is low and high frequency roll-off results. With the resistance tube biased to cut-off, the plate resistance approaches infinity and the frequency response is flat. Here again, the control can be picked off from the signal and high frequency noise suppression results. However, the control voltage should be derived mainly from the higher frequency portions of the signal. This is accomplished by insertion of a suitable high-pass filter in the side amplifier circuit. It should be mentioned that the type of noise suppression obtained with this circuit is *vertical*, not *horizontal*. The rate of attenuation obtained with this arrangement is always less than 6 db per octave.

Fig. 6 shows a low frequency noise suppression circuit which is suitable for variable-reluctance phonograph cartridges. The usual low frequency compensation is provided by R_1, R_2 and C_1. The resistance tube is shunted across C_1. When its plate resistance is low, C_1 is effectively short circuited. This removes the low frequency compensation with the over-all result that low frequency roll-off occurs. Once more the control voltage e_c is derived in the same manner as in the previous circuit except that a low-pass filter is inserted in the side amplifier. If several values of C_1 are used to provide different turnover frequencies the amount of low frequency noise suppression increases as the turnover frequency increases. Since the amount of low frequency noise and rumble also increases with the turnover frequency this characteristic is a distinct advantage; maximum noise suppression occurs under the conditions where it is most needed. Experimental curves for this circuit are shown in Fig. 8.

For those who prefer the selective feedback method of low frequency compensation the circuit of Fig. 7 is offered. Here the circuit is conventional except that the feedback condenser is shunted by a resistance tube. When the grid voltage of this tube approaches cut-off the operation of the circuit is entirely normal. When, however, the plate resistance is lowered, the feedback condenser is shorted out

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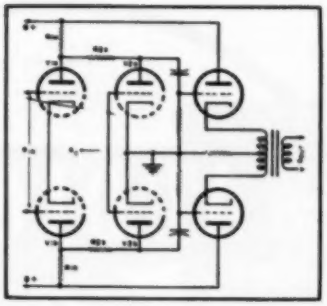

Fig. 4.

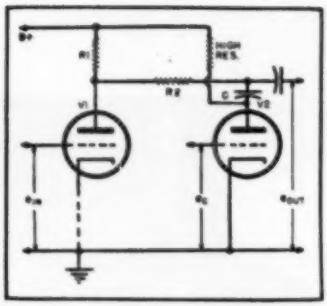

Fig. 5.

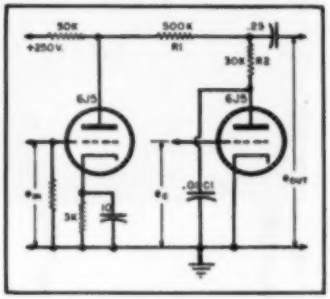

Fig. 6.

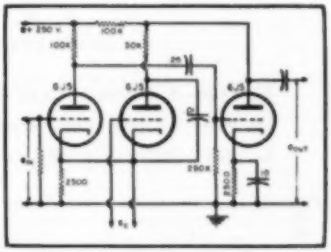

Fig. 7.

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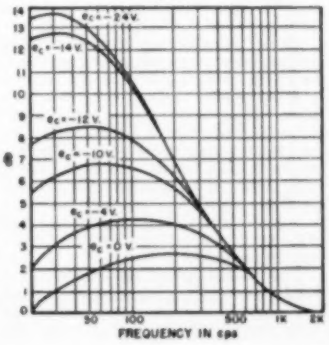
Fig. 8.



(Left) Bracinar dual-horn corner reproducer. (Right) RCA 15" duo-cone loudspeaker mounted in a bass reflex cabinet whose response is shown in graph, Fig. 5.

G & H Wood Products Co.'s folded-horn corner enclosure kit, shown assembled.

AUDIO Simplified

By
DAVID FIDELMAN

Part 8. A discussion of the power amplifier, its role as the final stage of amplification, in the electronic channel of reproduction.

THE power amplifier is the final stage of amplification in the electronic channel of the recording or reproducing system, and its function is to supply driving power to the output electromechanical transducer. The transducer, which converts this electrical energy into the appropriate mechanical motion, may be either a recording head or a loudspeaker. The output signal of the power amplifier must be free from distortion, and must satisfy power and output impedance.

Since electromagnetically-operated transducers, such as recording heads and loudspeakers, are generally very low impedance devices, the power amplifier must feed into a load impedance on the order of 2 to 15 ohms. The output impedance of the amplifier appears in the electromechanical equivalent circuit of the loudspeaker and affects the transient response, therefore it should be less than one-half the load impedance for best mechanical transient response.

The output power requirements for sound reproduction are determined by the specific application—particularly upon the size of the room in which the sound is being reproduced. The power required for rooms of different sizes can be determined from the curve of Fig. 1, which shows approximately the required amplifier power for reproduction of music when a standard cone loudspeaker is used. Generally it is desirable to have more power available than is shown in this curve, since the sharp transients which are often present in speech and music may require greater power if they are to be reproduced without distortion. In an average-sized room in the home, an amplifier and loudspeaker capable of handling 8 to 10 watts of electrical power will have an adequate reserve.

Design of Power Amplifiers

The power amplifier consists of a single amplifier stage using a tube or tubes that will supply the necessary output power and a transformer to match the relatively high plate impedance of the tube to the low impedance of the load. However, it is not simple to obtain the required power from the tubes and pass it through the output transformer to the load, while still maintaining the required distortion and frequency characteristics. For this reason, most of the difficulties in the reproducer circuits center about the power amplifier, and a wide variety of solutions has been attempted.

For a number of reasons, high-quality power amplifiers should be push-pull rather than single-ended:

1. Push-pull amplifiers have less distortion, because even-harmonic distortions are cancelled leaving only the odd-harmonic distortion.

2. Since the effects of the plate currents of the two tubes cancel one another in the transformer core, there is no d.c. saturation of a well-balanced output transformer, and the low frequency response is better.

3. The effects of power supply hum are greatly reduced, since this hum is cancelled out in the transformer.

4. The push-pull stage does not tend to cause motorboating in the amplifier. These advantages are so important that a push-pull circuit using two smaller tubes is definitely preferable to a single larger tube capable of de-

livering the same total power output.

There is considerable question whether it is preferable to use triodes or beam-power tetrodes in audio power amplifiers. It is generally agreed, however, that best results are obtained from push-pull amplifiers with overall negative feedback from output to input, including the output transformer in the feedback loop. The use of negative feedback in this application has the following advantages:

(*a*) The linearity of the output/input amplitude response curve is considerably improved, resulting in a decrease in harmonic distortion and intermodulation;

(*b*) The frequency response is improved, becoming flatter over a wider range of frequencies;

(*c*) The output impedance is reduced, thus improving the transient response of the loudspeaker;

(*d*) The effects of changes in tube characteristics, of random changes of the parameters of the amplifier, and of power supply voltage changes are reduced.

Other circuits in use at the present time make use of triodes without negative feedback and of beam-power tetrodes with feedback. Triode amplifiers have an advantage in that their distortion components contain a smaller distribution among the higher-order harmonics than beam-power tetrodes, therefore have a less unpleasant type of intermodulation distortion. However, beam-power tubes with feedback give better results than triodes without feedback, although not as good as triodes with feedback, and in general give better power efficiency and require lower drive voltages.

The choice of tubes for the specific amplifier being designed depends upon the power required, as determined from the curve of Fig. 1. Basic information concerning the operation of the various power tubes—such as power output, plate load impedance, grid bias voltage, plate voltage, etc., are given in the receiving tube handbook, and can be used as a guide in the selection of tubes. However, the final design of the power stage must be done with the use of the plate-current characteristics.

In designing the push-pull amplifier from the plate-current characteristic curves which are given for the tubes, a *composite* set of curves must be constructed and used instead of those given for the single tube. The reason this is necessary is that the steady-state current in each tube has no effect on the audio output signal because of the transformer coupling, and it is only the dynamic difference in the plate currents of the two tubes which appears in the secondary winding of the transformer. The composite curves are constructed essentially by subtracting the currents through the two tubes to approximate the effect of the transformer. This is done by placing the plate voltage-current curves of the individual tubes back-to-back, with the common operating voltage superimposed, and then averaging the plate current for grid-potential curves corresponding to the same applied signal, as shown in Fig. 2.

The precise manner in which the composite curves are constructed may best be understood by a more detailed study of Fig. 2, which illustrates this procedure for a push-pull 2A3 amplifier. Two sets of curves are redrawn from the tube handbook, and each set of curves is taken to represent one of the tubes. Assuming a plate voltage of 300 volts, place the two sets of curves back-to-back with the 300 points coinciding as shown. Then, assuming some value of grid bias voltage (for example, —60 volts as shown), draw a line which represents the difference in the currents of the two tubes. Next, draw similar plate-current-difference lines for the various other values of grid voltage. (It should be noted that the curve for —70 volts for one tube is matched with —50 volts for the other tube, since the signal voltages on the two grids are opposite in phase, and the voltage on one increases while the voltage on the other decreases.) These lines will be practically straight, and represent the current-voltage curves taking into account the transformer and the push-pull method of operation of the circuit.

The load line is then drawn over the composite characteristics in the same manner as for an ordinary set of tube characteristics. The load line in Fig. 2 intersects the zero-current axis at 300 volts (which was initially selected by superimposing the two sets of curves at this voltage), which is the quiescent or zero-signal operating point. When extended, the load line intersects the zero-voltage axis at 400 milliamperes, therefore its resistance is 750 ohms. Multiplying by 4 gives the total plate-to-plate load resistance, which is thus 3000 ohms in this case. When signals are applied to the grids, the values of the plate currents of the tubes lie along this line. Desirable operating conditions for the two 2A3 tubes in a push-pull amplifier are therefore: Plate voltage, 300 volts; Grid bias voltage, —60 volts; and Load resistance

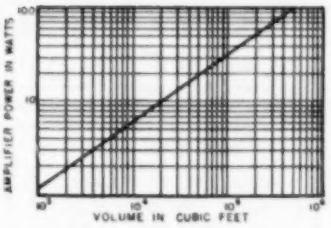


Fig. 1. Approximate amplifier power requirements for rooms of various dimensions.

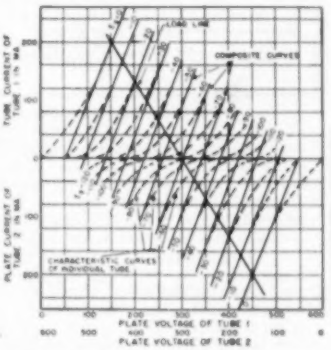
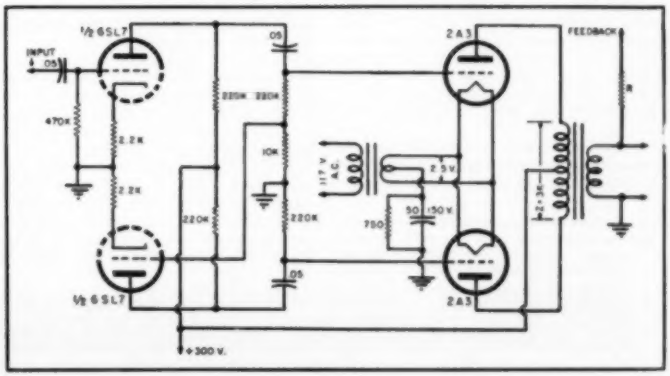

LOAD LINE
COMPOSITE CURVES
CHARACTERISTIC CURVES OF INDIVIDUAL TUBE
PLATE CURRENT OF TUBE 1 IN MA
PLATE CURRENT OF TUBE 2 IN MA
PLATE VOLTAGE OF TUBE 1
PLATE VOLTAGE OF TUBE 2

Fig. 2. Construction of the composite curves used in designing a push-pull amplifier.

(plate-to-plate), 3000 ohms. However, the composite curves represent the signal currents through the plate load, and not the actual tube currents. Each tube will still draw 40 ma. of plate current for zero signal. The total plate current for each value of grid voltage is found by adding the two plate currents, instead of subtracting them as for the composite curves, and the average plate current is found by averaging the sum of the two plate currents for a complete signal cycle.

This method of graphical construction for the push-pull power amplifier is the basis for the data given in the tube handbooks, and whenever such in-

Fig. 3. A basic push-pull amplifier designed from the composite curves of Fig. 2.



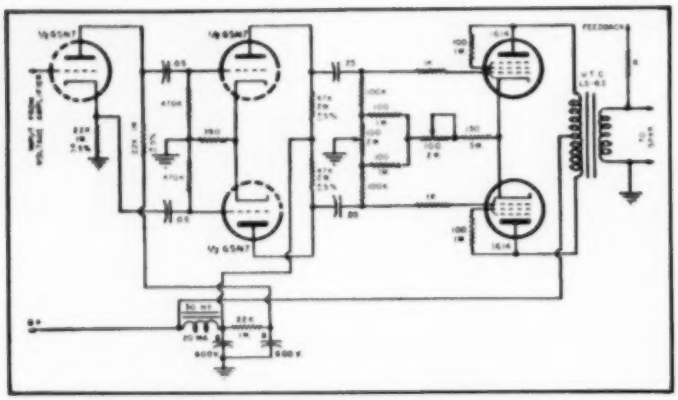
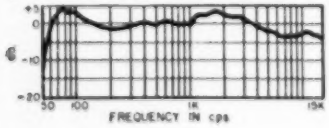


Fig. 4. A modified schematic of the Williamson power amplifier circuit.

formation is given it can be assumed to be the same values as would be obtained by an independent calculation of this type. It forms the basis of the various types of push-pull amplifiers which are in general use at the present time. The schematic diagram of a basic push-pull power amplifier circuit based upon these design principles is shown in Fig. 3. The driver stage is a typical phase-inverter amplifier circuit which has already been described in an earlier article in this series. The input signal from the voltage amplifier is amplified by the first triode and drives one of the push-pull tubes, while the second triode section amplifies a small part of this drive voltage with a 180-degree phase reversal to drive the second push-pull grid with the proper voltage and phase. The power amplifier consists of two 2A3's in the circuit designed from the curves in Fig. 2, with +300 volts on the plates, −60 volts grid bias, and a 3000 ohm plate-to-plate output transformer matched to the loudspeaker impedance. (The feedback connection which is indicated will go to an appropriate point in the voltage amplifier.) The grid drive signal voltage required by each 2A3 for full output is approximately 40 volts rms, and is easily obtained from the 6SL7 driver tubes. The amplifier, as shown, is capable of delivering 10 watts into the loudspeaker, and will give quite good results in the average home sound reproducing system. This circuit is shown using triodes, but it can also be designed for pentodes or beam-power tetrodes such as the 6L6 and 6V6.

Another power amplifier circuit which has recently been designed in England and has achieved wide popularity because of its excellent performance is the *Williamson amplifier*. The schematic circuit diagram of the power amplifier section is shown in Fig. 4. The input signal from the voltage amplifier is applied to a cathode-follower phase inverter, which supplies the two equal signals, opposite in phase, required by the push-pull amplifier. These signals, however, do not drive the power amplifier directly, but are instead amplified in a push-pull driver stage that supplies the signal voltage for the power amplifier grids. The power tubes are connected as triodes and feedback is taken from the secondary of the output transformer to an appropriate point in the voltage amplifier. In this circuit, the output transformer is extremely important, and should very closely meet the original specifications for satisfactory performance. Too low a primary inductance in the transformer tends to produce instability at the low frequencies, while variations in the leakage inductance and capacities between the windings will affect the high frequency response. At the present time a number of manufacturers are producing transformers for use with this circuit, and it is also possible to purchase commercial kits which contain all the components necessary for construction of this amplifier. Commercially constructed amplifiers based upon this design are also available, and indication of the performance of this circuit may be obtained from the following typical specifications: Frequency response, ± 0.1 db 20-20,000 cps; Frequency response, ± 2 db 5-100,000 cps; Harmonic distortion, less than 0.1% at 10 watts output at mid-frequencies; Intermodulation, less than 0.5% at 10 watts output. These characteristics are extremely good, and are in fact considerably better than what are considered to be the minimum requirements for good reproduction.

Fig. 5. Frequency response of a high-quality speaker mounted in good bass-reflex cabinet.



Loudspeakers

In designing and setting up any sound reproduction system, it should always be kept in mind that the quality of the reproduced sound can be no better than that produced by the worst component in the system. Generally this "worst component in the system" is the loudspeaker. When it is considered that the loudspeaker is required to reproduce the same sound which is produced by all the instruments of a large orchestra, from the upper limit of audibility down to the lowest notes which can be produced by the pipe organ, the difficult task which it is called upon to accomplish becomes more clearly evident. The improvement in the quality of reproduction which has taken place has resulted largely from the improvement in loudspeaker design and manufacture.

The loudspeaker must be of comparable quality to the rest of the system, and should meet the same requirements as the rest of the system. That is, when an electrical signal of the proper characteristics is applied to the input terminals, the output sound should be free of frequency, amplitude, transient, and other distortions at all rated input power levels. Ideally, the distortions introduced by the loudspeaker should be within the limits specified for the rest of the system, but in practice there are no speakers available at the present time which meet these requirements. (However, this does not mean that the quality of the rest of the system should be made worse, since this would only further lower the over-all quality of the system.) It is, in fact, difficult even to measure the characteristics of loudspeakers, since such a measurement requires a sound-standard microphone and must be done in a room with no resonances and whose walls do not reflect any sound to interfere with the measurement. The information which is supplied by the manufacturer must be accepted by the experimenter who hasn't extensive testing facilities, and this information is generally quite reliable.

The frequency response curve of a typical high-quality commercial loudspeaker is shown in Fig. 5. This response illustrates some of the important factors which should be found in a good loudspeaker:

(*a*) The response should be reasonably flat over a frequency range of 50-10,000 cps.

(*b*) The frequency response curve should be fairly smooth, with as few sharp peaks and dips as possible, since these discontinuities in the response represent mechanical resonances which result in bad transient response.

(*c*) The power rating of the speaker or speakers used should correspond to the rest of the system and to the requirements of the listening room, so that there will be no distortion at high sound levels.

Even these requirements can only be a guide in the selection of appropriate loudspeakers for sound reproduction systems, since the loudspeaker is a complex electromechanical system whose properties in relation to the ear

(*Continued on page* 108)

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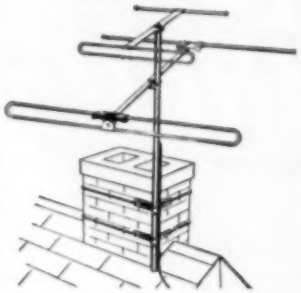

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- No wiring necessary—simple as removing a tube.
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Extra tips..... **15¢**

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- Tubes 1S5, 3S4, 1R5, 1U4 and Selenium Rectifier.
- Alnico V PM Speaker.
- Attractive airplane dial, luggage type case.
- Small size. 5 ¼" H x 8 ⅜" W x 4 ¾" D.

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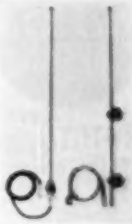
List Price, **$59.95**
YOUR PRICE.....**$41.95**



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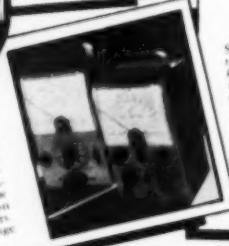
Features OF THE NEW 1952 Heathkits

PROOF OF THE NEW O-7 OSCILLOSCOPE'S OUTSTANDING PERFORMANCE

Below are actual, unretouched photographs showing the outstanding frequency response characteristics of the NEW 1952 HEATHKIT OSCILLOSCOPE MODEL O-7. To the left is a 10 KC square wave — to the right a 4 MC sine wave as they actually appear on the screen. Two highly severe tests to make on any scope (only the best of scopes will show traces like these) — and the O-7 really comes through.

COMPANION VACUUM TUBE VOLTMETERS

Here are the two NEW 1952 VACUUM TUBE VOLTMETER COMPANION PIECES. Matched instruments of new design to open up the whole field of DC, AC, and resistance measurements for you. The new greatly reduced size combines style, beauty, and compactness. The V-5 and AV-1 have the new panel and cabinet construction as shown on the right. A tremendous part of volmeters. Small in size but virtual giants in the range of measurements they make.



NEW STYLE AND BEAUTY

Style that's modern, yet functional — that's the trend of today — and Heathkits are right up to the minute. Note the cut showing the new V-5 and AV-1 cabinet and panel construction. The front panel and rear cover slide right over the recessed flange of the case thereby eliminating sharp edges and pointed corners. The voltmeter kits aren't "shelf" or mounted instruments — they're moved about on the bench a lot and thus the new compact size and specially designed cabinets — Another 1952 Heathkit feature.

A STATEMENT FROM SIMPSON ELECTRIC CO.

In choosing Simpson Meters for their Heathkit VTVM, the Heath Co. has set a new high standard of kit meter quality. The same high quality of material, workmanship and design that has given Simpson the reputation for building "Instruments That Stay Accurate" is found in the Heathkit Meter Movement.

SIGNED
SIMPSON ELECTRIC CO.

A STATEMENT FROM CHICAGO TRANSFORMER

It is indeed gratifying to note the outstanding sales records you are building with you Heathkits.

This sales success is readily understandable, since we are cognizant of the high quality standards you have established for your component suppliers.

We at Chicago Transformer are proud that our product has contributed to the recognized quality and increasing popularity of Heathkits.

CHICAGO TRANSFORMER DIVISION
Essex Wire Corporation

L. S. RACINE
Vice-President and Sales Manager

HEATHKIT PRECISION RESISTORS

Where exact resistance values are required for instrument accuracy, the Heath Co. has spared no effort in supplying the finest resistors available. Precision resistors as manufactured by Continental Carbon Inc., and Wilcor Corp., meet the rigorous JAN (Joint Army-Navy) specifications and are small in size, extremely non-inductive, highly stable, have a low temperature coefficient, and can be held to great accuracy. You'll find quality components in Heathkits.

COLLEGES USE HEATHKITS

Colleges and Universities throughout the country are using Heathkits in their electrical engineering, radio, and physics laboratories — Heathkits are the answer to good test equipment at low cost, plus being rugged, dependable, and accurate. Trade schools are having their students build Heathkits to obtain a first hand working knowledge of test equipment and to get the practical experience gained by construction. Heathkits fill school needs.

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New LABORATORY LINE HEATHKITS

NEW *Heathkit*
A.C. VACUUM TUBE
VOLTMETER KIT

MODEL AV-1
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$29.50

Now — as a Heathkit — at a price anyone can afford, an AC VTVM. A new kit to make possible those sensitive AC measurements required by audio enthusiasts, laboratories, and experimentors. Here is the kit that the audio men have been looking for. Its tremendous range of coverage makes possible measurements of audio amplifier frequency response — gain or loss of audio stages — characteristics of audio filters and attenuators — hum investigation — and literally a multitude of others. Ten ranges consisting of full scale .01, .03, .1, .3, 1, 3, 10, 30, 100, 300 volts RMS assure easy and more accurate readings. Ten ranges on DB provide for measurements from −52 to +52 DB. Frequency response within 1 DB from 20 cycles to 50 KC.

The ingenious circuitry incorporates precision multiplier resistors for accuracy, two amplifier stages using miniature tubes, a unique bridge rectifier meter circuit, quality Simpson meter with 200 microampere movement, and a clean layout of parts for easy wiring. A high degree of inverse feedback provides for stability and linearity.

Simple operation is accomplished by the use of only one control, a range switch which changes the voltage ranges in multiples of 1 and 3, and DB ranges in steps of 10.

The instrument is extremely compact, cabinet size — 4½" deep x 4-11/16" wide x 7⅞" high, and the newly designed cabinet makes this the companion piece to the VTVM. For audio work, this kit is a natural.

NEW *Heathkit*
AUDIO FREQUENCY METER KIT

MODEL AF-1
Shipping weight 12 lbs.

$34.50

A NEW Heathkit Audio Frequency Meter — the ideal instrument for determining frequencies from 20 cycles to 100 KC. Set the selector switch to the proper range — feed the signal into the input terminals — and read the frequency from the meter — completely simple to operate and yet dependable results.

Quality Simpson 200 microampere meter has two plainly marked scales (0-300 0-300). These scales, read in conjunction with the seven position selector switch, give full scale readings of 100, 300, 1000, 3000, 10,000, 30,000, and 100,000 cycles. Convenient ranges for fast and easy readings.

For greatest accuracy, the 1-3-10 ratio of ranges is maintained and each range has individual calibrating control.

Input impedance is high (1 megohm) for negligible circuit loading. A signal voltage anywhere between 2 and 300V can be fed directly into the instrument and a change in signal voltage between these limits will not affect the meter reading. In addition, input wave shape is not critical (the unit will read the frequency of either sine wave or square wave input).

The tube complement consists of a 6SJ7 amplifier and clipper, 6V6 amplifier and clipper, 6H6 meter pulse rectifier, 6X5 power supply rectifier, and OD3/VR150 voltage regulator.

Construction is simple, and quality components are used throughout.

NEW *Heathkit*
INTERMODULATION ANALYZER KIT

MODEL IM-1
Shipping wt. 18 lbs.

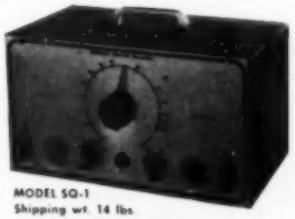
$39.50

Intermodulation testing of audio equipment is rapidly being accepted by more and more engineers and audio experts as the best way to determine the characteristics of audio amplifiers, recording systems, networks, etc. — shows up those undesirable characteristics which contribute to listening fatigue when all other methods fail.

The Heathkit Intermodulation Analyzer supplies a choice of two high frequencies (3000 cycles and a higher frequency) and one low frequency (60 cycles). Both 1:1 or 4:1 ratios of low to high frequencies can be set up for IM testing, and the ratios are easily set by means of a panel control and the instrument's own VTVM. An output level control supplies the mixed signal at the desired level with an output impedance of two thousand ohms. The Analyzer section has input level control and proper filter circuits feeding the instrument's VTVM to read intermodulation directly on full scale ranges of 30%, 10% and 3%. Built-in power supply furnishes all necessary voltages for operating the instrument.

You won't want to be without this new and efficient means of testing.

NEW
Heathkit SQUARE WAVE
GENERATOR KIT



MODEL SG-1
Shipping wt. 14 lbs.

$29.50

The new Heathkit Square Wave Generator Kit with its 100 KC square wave opens an entirely new field of audio testing. Square wave testing over this wide range will quickly show high and low frequency response characteristics of circuits — permit easy adjustment of high frequency compensating networks used in vidio amplifiers — identify ringing in circuits — demonstrate transformer characteristics, etc.

The circuitry consists of a multivibrator stage, a clipping and squaring stage, and a cathode follower output stage. The power supply is transformer operated and utilizes a full wave rectifier tube with 2 sections of LC filtering.

As a multivibrator cannot be accurately calibrated, a provision is provided to allow the instrument to be accurately synchronized with an accurate external source when extreme accuracy is required.

The low impedance output is continuously variable between 0 and 25 volts and operation is simple. You'll really appreciate the wide range of this instrument, 10 cycles to 100 kilocycles — continuously variable. Kit is complete with all parts and instruction manual, and is easy to build.

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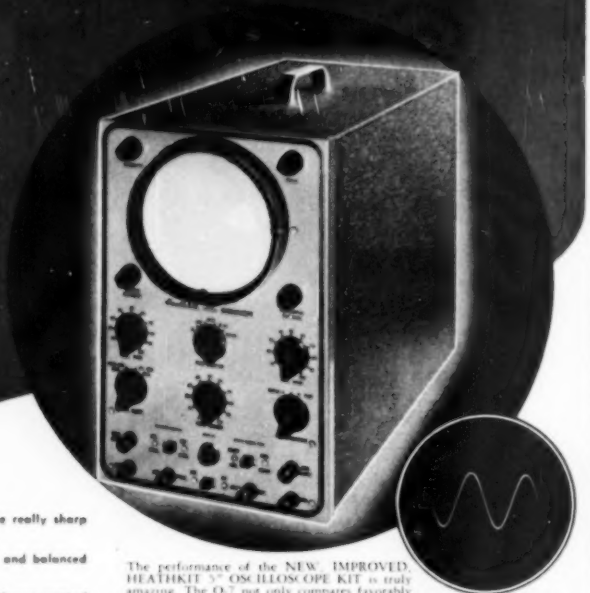
Heathkit

OSCILLOSCOPE KIT

MODEL O-7

SHIPPING WEIGHT 24 LBS.

$43.50



Features

- New "spot shape" control for spot adjustment — to give really sharp focusing.
- A total of ten tubes including CR tube and five miniatures.
- Cascaded vertical amplifiers followed by phase splitter and balanced push-pull deflection amplifiers.
- Greatly reduced retrace time.
- Step attenuated — frequency compensated — cathode follower vertical input.
- Low impedance vertical gain control for minimum distortion.
- New mounting of phase splitter and deflection amplifier tubes near CR tube base.
- Greatly simplified wiring layout.
- Increased frequency response — useful to 5 Mc.
- Tremendous sensitivity .03V RMS per inch Vertical — 6V RMS per inch Horizontal.
- Dual control in vernier sweep frequency circuit — smoother acting.
- Positive or negative peak internal synchronization.

The performance of the NEW, IMPROVED, HEATHKIT 5" OSCILLOSCOPE KIT is truly amazing. The O-7 not only compares favorably with equipment costing 4 and 5 times as much, but in many cases literally surpasses the really expensive equipment. The new, and carefully engineered circuit incorporates the best in electronic design — and a multitude of excellent features all contribute to the outstanding performance of the new scope.

The VERTICAL CHANNEL has a step attenuated, frequency compensated vertical input which feeds a cathode follower stage — this accomplishes improved frequency response, presents a high impedance input, and places the vertical gain control in a low impedance circuit for minimum distortion. Following the cathode follower stage is a twin triode — cascaded amplifiers to contribute to the scope's extremely high sensitivity. Next comes a phase splitter stage which properly drives the push-pull, hi-gain, deflection amplifiers (whose plates are directly coupled to the vertical deflection plates). This fine tube lineup and circuitry give a sensitivity of .03V per inch RMS vertical and useful frequency response to 5 Mc.

The HORIZONTAL CHANNEL consists of a triode phase splitter with a dual potentiometer (horizontal gain control) in its plate and cathode circuits for smooth, proper driving of the push-pull horizontal deflection amplifiers. As in the vertical channel, horizontal deflection amplifier plates are direct coupled to the CR tube horizontal deflection plates (for improved frequency response).

The WIDE RANGE SWEEP GENERATOR circuit incorporates a twin triode multivibrator stage for producing a good saw-tooth sweep frequency (with faster retrace time). Has both coarse and vernier sweep frequency controls.

And the scope has internal synchronization which operates on either positive or negative peaks of the input signal — both high and low voltage rectifiers — Z-axis modulation (intensity modulation) — new spot shape (astigmatism) control for spot adjustment — provisions for external synchronization — vertical centering and horizontal centering controls, wide range focus control — and an intensity control for giving plenty of trace brilliance.

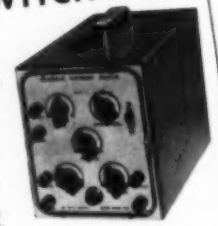
The Model O-7 EVEN HAS GREAT NEW MECHANICAL FEATURES — A special extra-wide CR tube mounting bracket is provided so that the vertical cascade amplifier, vertical phase splitter, vertical deflection amplifier, and horizontal deflection amplifier can mount near the base of the CR tube. This permits close connection between the above stages and to the deflection plates; distributed wiring capacity is greatly reduced, thereby affording increased high frequency response.

The power transformer is specially designed so as to keep its electrostatic and electromagnetic fields to a minimum — also has an internal shield with external ground lead.

You'll like the complete instructions showing all details for easily building the kit — includes pictorials, step-by-step construction procedure, numerous sketches, schematic, circuit description. All necessary components included — transformer, cabinet, all tubes (including CR tube), completely punched and formed chassis — nothing else to buy.

NEW INEXPENSIVE *Heathkit*

ELECTRONIC SWITCH KIT



The companion piece to a scope — Feed two different signals into the switch, connect its output to a scope, and you can observe both signals — each as an individual trace. Gain of each input is easily set (gain A and gain B controls), the switching frequency is simple to adjust (coarse and fine frequency controls), and the traces can be superimposed for comparison or separated for individual study (position control).

Use the switch to see distortion, phase shift, clipping due to improper bias, both the input and output traces of an amplifier — as a square wave generator over limited range.

The kit is complete; all tubes, switches, cabinet, power transformer, and all other parts, plus a clear, detailed construction manual.

Model S-2
Shipping Wt. 11 lbs.

Only

$19.50

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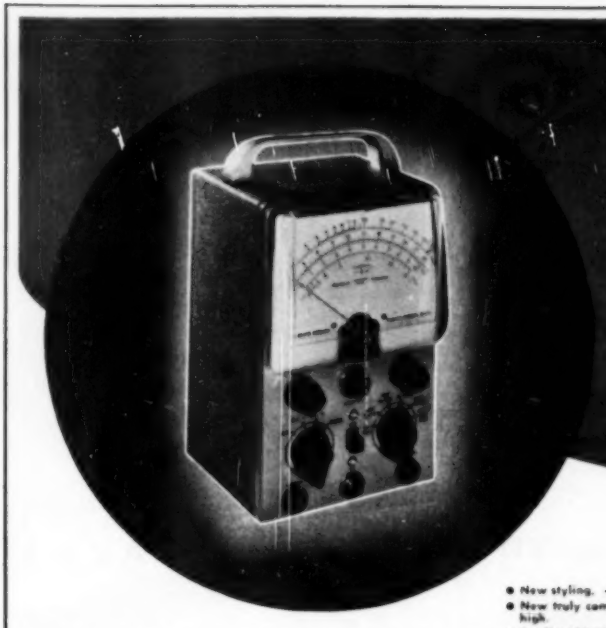


THE *New* 1952 *Heathkit* VTVM KIT

MODEL V-5
SHIPPING WT. 5 LBS.

$24.50

Features

- **New styling, — formed case for beauty.**
- **New truly compact size. Cabinet 6¼" deep by 4-11/16" wide by 7⅛" high.**
- **Quality 200 microamp meter.**
- **New ohms battery holding clamp and spring clip — assurance of good electrical contact.**
- **Highest quality precision resistors in multiplier circuit.**
- **Calibrates on both AC and DC for maximum accuracy.**
- **Terrific coverage — reads from ½V to 1000V AC, ½V to 1000V DC, and .1 to over 1 billion ohms resistance.**
- **Large, clearly marked meter scales indicate ohms, AC Volts, DC Volts, and DB — has zero set mark for FM alignment.**
- **New styling presents attractive and professional appearance.**

A real beauty — you'll have only highest praise for this NEW MODEL VACUUM TUBE VOLTMETER. Truly a beautiful little instrument — and it's more compact than any of our previous models. Note the new rounded edges on the front panel and rear cover. The size is greatly reduced to occupy a minimum of space on your workbench — yet the meter remains the same large size with plainly marked scales.

A set of specially designed control mounting brackets permit calibration to be performed with greatest ease — also makes for ease in wiring. New battery mounting clamp holds ohms battery tightly into place, and base spring clip insures a good connection to the ohms string of resistors.

The circuitry employs two vacuum tubes — A duo diode operating when AC voltage measurements are taken, and a twin triode in the circuit at all times. The cathode balancing circuit of the twin triode assures sensitive measurements, and yet offers complete protection to the meter movement. Makes the meter burn-out proof in a properly constructed instrument.

Quality components are used throughout — 1% precision resistors in the multiplier circuit—conservatively rated power transformer—Simpson meter movement — excellent positive detent, smooth acting switches — sturdy cabinet, etc.

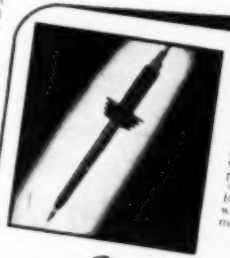
And you can make a tremendous range of measurements — ½V to 1000V AC, ½V to 1000V DC, .1 to over 1 billion ohms, and DB. Has mid-scale zero level marking for quick FM alignment. DB scale in red for easy identification — all other scales a sharp, crisp black for for easy reading.

A four position selector switch allows operator to rapidly set the instrument for type or reading desired—positions include AC V, DC + ▼, DC —V, and Ohms. DC — position allows negative voltage to be rapidly taken. Zero adjust and ohms adjust controls are conveniently located on front panel.

Enjoy the numerous advantages of using a VTVM. Its high input impedance doesn't "load" circuits under test — therefore, assures more accurate and dependable readings in high impedance circuits such as resistance coupled amplifiers, AVC circuits, etc. Note the 30,000 VDC probe kit and the RF probe kit — available at low extra cost and specially designed for use with this instrument. With these two probes, you can make DC voltage measurements up to 30,000V, or make RF measurements — added usefulness to an already highly useful instrument.

The instruction manual is absolutely complete — contains a host of figures, pictorials, schematic, detailed step-by-step instructions, and circuit description. These clear, detailed instructions make assembly a cinch.

And every part is included — meter, all controls, pilot light, switches, test leads, cabinet, instruction manual, etc.



Heathkit 30,000V DC
PROBE KIT

A new 30,000 V DC Probe Kit to handle high voltages with safety. For TV service work and all other high voltage applications. Sleek looking — Two color molded plastic — Red body and guard — jet black handle. Comes with connector, cable, and PL55 type plug. Plugs into Heathkit VTVM so that 300V scale is conveniently multiplied by 100. Can be used with any standard 11 megohm VTVM.

$5.50

No. 336 High Voltage Probe Kit
Shipping Wt. 2 lbs.

Heathkit
RF PROBE KIT

This RF Probe Kit comes complete with probe housing, crystal diode detector, connector, lead and plug and all other parts plus clear assembly instructions. Extends range of Heathkit VTVM to 250 Mc. ± 10%. Works on any 11 megohm input VTVM. Specify No. 309 RF Probe Kit.

$5.50

Ship. Wt. 1 lb.

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Heathkit

SIGNAL GENERATOR KIT

Model SG-6
Shipping Wt. 7 lbs.

$19.50

The new Heathkit Signal Generator Kit has dozens of improvements. Covers the extended range of 160 Kc to 50 megacycles on fundamentals and up to 150 megacycles on useful calibrated harmonics; makes this Heathkit ideal as a marker oscillator for TV. Output level can be conveniently set by means of both step attenuator and continuously variable output controls. Instrument has new miniature HF tubes to easily handle the high frequencies covered.

Uses 6C4 master oscillator and 6C4 sine wave audio oscillator. The kit is transformer operated and a husky selenium rectifier is used in the power supply. All coils are precision wound and checked for calibration making only one adjustment necessary for all bands.

New sine wave audio oscillator provides internal modulation and is also available for external audio testing. Switch provided allows the oscillator to be modulated by an external audio oscillator for fidelity testing of receivers. Comes complete, all tubes, cabinet, test leads, every part. The instruction manual has step-by-step instructions and pictorials. It's easy and fun to build a Heathkit Model SG-6 Signal Generator.

Heathkit

CONDENSER CHECKER KIT

Only

$19.50

Model C-2
Shipping Wt. 6 lbs.

Checks all types of condensers — paper — mica — ceramic — electrolytic. All condenser scales are direct reading and require no charts or multipliers. Covers range of .00001 MFD to 1000 MFD. A Condenser Checker that anyone can read. A leakage test and polarizing voltage for 20 to 500 V provided. Measures power factor of electrolytics between 0% and 50% and reads resistance from 100 ohms to 5 megohms. The magic eye indicator makes testing easy.

The kit is 110V 60 cycle transformer operated and comes complete with rectifier tube, magic eye tube, cabinet, calibrated panel and all other parts. Has clear detailed instructions for assembly and use.

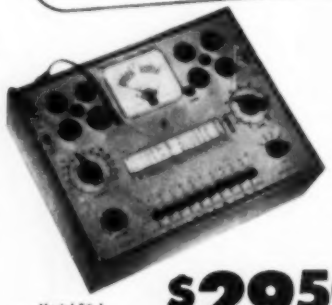
NEW *Heathkit*

SIGNAL TRACER AND UNIVERSAL TEST SPEAKER KIT

$19.50

Model T-2
Shipping Wt. 7 lbs.

The popular Heathkit Signal Tracer has now been combined with a universal test speaker at no increase in price. The same high quality tracer follows signal from antenna to speaker — locates intermittents — finds defective parts quicker — saves valuable service time — gives greater income per service hour. Works equally well on broadcast, FM, or TV receivers. The test speaker has an assortment of switching ranges to match either push-pull or single output impedances. Also tests microphones, pickups and PA systems. Comes complete: cabinet, 110V 60 cycle power transformer, tubes, test probe, all necessary parts, and detailed instructions for assembly and use.



Model TC-1
Shipping Wt. 12 lbs.

$29.50

Heathkit

TUBE CHECKER KIT

The Tube Checker is a MUST for radio repair men. Often customers want to SEE tubes checked, and a checker like this builds customer confidence. In your repairing, you will have a multitude of tubes to check — quickly. The Heathkit tube checker will serve all these functions — it's good looking (with a polished birch cabinet and an attractive two color panel) — checks 4, 5, 6, 7 prong Octals, Loctals, 7 prong miniatures, 9 prong miniatures, pilot lights, and the Hytron 5 prong types. AND IT'S FAST TO OPERATE — the gear driven, free-running roll chart lists hundreds of tubes, and the smooth acting, simplified switching arrangement gives really rapid set-ups.

The testing arrangement is designed so that you will be able to test new tubes of the future — without even waiting for factory data — protection against obsolescence.

You can give tubes a thorough testing — checks for opens, shorts, each element individually, emission, and for filament continuity. A large BAD-?-GOOD meter scale is in three colors for easy reading and also has a "line-set" mark.

You'll find this tube checker kit a good investment — and it's only $29.50.

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NEW 1952 *Heathkit*

BATTERY ELIMINATOR KIT

$24.50

Model BE-3
Shipping Wt. 17 lbs.

- Can be used as battery charger.
- Continuously variable output 0 - 8 Volts — not switch type.
- Heavy duty Mallory 17 disk type magnesium copper sulfide rectifier.
- Automatic overload relay for maximum protection. Self-resetting type.
- Ideal for battery, aircraft and marine radios.
- Dual Volt and Ammeters read both voltage and amperage continually — no switching.

The new Heathkit Model BE-2 incorporates the best. Continuously variable output control is of the variable transformer type with smooth wiper type contacts.

There are no switches or steps and voltage between 0 and 8 Volts is available at 10 Amperes continuous and 15 Amperes intermittent. Maximum safety from overloads and shorts provided by automatic overload relay which resets itself when overload is removed.

The new rectifier is a 17 plate Mallory magnesium copper sulfide type. This is the most rugged type available for long trouble-free use.

Output is continuously metered by both a 0 - 10 Volt Voltmeter and a 0 - 15 Amp Ammeter. Shorted vibrators indicated instantly by ammeter.

Equip now for all types of service — aircraft — marine — auto and battery radios — this inexpensive instrument vastly increases service possibilities — better be ready when the customer walks in.

NEW *Heathkit*

SINE AND SQUARE WAVE AUDIO GENERATOR KIT

Designed with versatility, usefulness and dependability in mind, the AG-7 gives you the two most needed wave shapes right at your fingertips — the sine wave and the square wave.

The range switch and plainly calibrated frequency scale give rapid and easy frequency selection, and the output control permits setting the output to any desired level.

A high-low impedance switch sets the instrument for either high or low impedance output — on high to connect a high impedance load, and on low to work into a low impedance transformer with negligible DC resistance.

Coverage is from 20 to 20,000 cycles, and distortion is at a minimum — you can really trust the output wave shape.

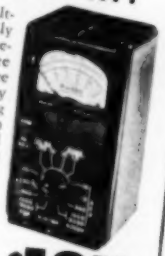
Six tubes, quality 4 gang tuning condenser, power transformer, metal cased filter condenser, 1% precision resistors in the frequency determining circuit, and all other parts come with the kit — plus, a complete construction manual — A tremendous kit, and the price is truly low.

Model AG-7
Shipping Wt. 15 lbs.

$34.50

THE NEW *Heathkit*

HANDITESTER KIT



A precision portable volt-ohm milliammeter. Uses only high quality parts — All precision 1% resistors, three deck switch for trouble-free mounting of parts, specially designed battery mounting bracket, smooth acting ohm adjust control, beautiful molded bakelite case, 400 micro-amp meter movement, etc.

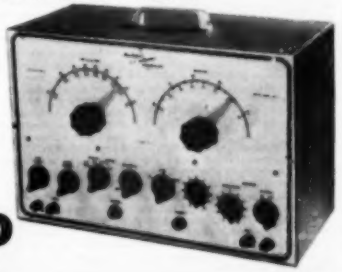
DC and AC voltage ranges 10 - 30 - 300 - 1000 - 5000V. Ohms range 0 - 5000 and 0 - 500,000. Range Milliamperes 0 - 10 Ma, 0 - 100 Ma. Easily assembled from complete instructions and pictorial diagrams.

$13.50

Model M-1
Shipping Wt. 3 lbs.

NEW *Heathkit*

T.V. ALIGNMENT GENERATOR KIT



Here is an excellent TV Alignment Generator designed to do TV service work quickly, easily, and properly. The Model TS-2 when used in conjunction with an oscilloscope provides a means of correctly aligning television receivers.

The instrument provides a frequency modulated signal covering, in two bands, the range of 10 to 90 Mc. and 150 to 230 Mc.— ALL ALLOCATED TV CHANNELS AS WELL AS IF FREQUENCIES ARE COVERED.

An absorption type frequency marker covers from 20 to 75 Mc. in two ranges—therefore, you have a simple, convenient means of frequency checking of IF's, independent of oscillator calibration.

Sweep width is controlled from the front panel and covers a sweep deviation of 0-12 Mc.—all the sweep you could possibly need or want.

And still other excellent features are: Horizontal sweep voltage available at the front panel and controlled with a phasing control—both step and continuously variable attenuation for setting the output signal to the desired level—a convenient instrument stand-by position—tensior drive of both oscillator and marker tuning condensers—and blanking for establishing a single trace with base reference level. Make your work easier, save time, and repair with confidence—order your Heathkit TV Alignment Generator now!

Model TS-2
Shipping Wt. 20 lbs.

$39.50

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Heathkit IMPEDANCE BRIDGE KIT

This Impedance Bridge Kit is really a favorite with schools, industrial laboratories, and serious experimenters. An invaluable instrument for those doing electrical measurements work. Reads resistance from .01 Ohms to 10 meg., capacitance from .00001 to 100 MFD, inductance from 10 microhenries to 100 henries, dissipation factor from .002 to 1, and storage factor from 1 to 1000. And you don't have to worry about selecting the proper bridge circuit for the various measurements — the instrument automatically makes the correct circuit when you set up for taking the measurement you want. Bridge utilizes Wheatstone, Hay, Maxwell, and capacitance comparison circuits for the wide range and types of measurements possible. And it's self powered — has internal battery and 1000 cycle hummer. No external generator required — has provisions for external generator if measurements at other than 1000 cycles are desired. Kit utilizes only highest quality parts. General Radio main calibrated control. Mallory ceramic switches, excellent 200 microamp zero center galvanometer, laboratory type binding posts with standard ¾ inch centers. 1% precision ceramic-body type multiplier resistors, beautiful birch cabinet and ready calibrated panel. (Headphones not included.)

Take the guesswork out of electrical measurements — order your Heathkit Impedance Bridge kit today — you'll like it.

Model IB-1B
Shipping Wt. 15 lbs.

$69.50

Heathkit LABORATORY RESISTANCE DECADE KIT

$19.50

Shipping Wt. 4 lbs.

An indispensable piece of laboratory equipment — the Heathkit Resistance Decade Kit gives you resistance settings from 1 to 99,999 ohms IN ONE OHM STEPS. For greatest accuracy, 1% precision ceramic-body type resistors and highest quality ceramic wafer switches are used.

Designed to match the Impedance Bridge above, the Resistance Decade Kit has a beautiful birch cabinet and attractive panel. It's easy to build, and comes complete with all parts and construction manual.

Heathkit LABORATORY POWER SUPPLY KITS

Limits:

No load	Variable	150-400V DC
25 MA	Variable	30-318V DC
50 MA	Variable	25-250V DC

Higher loads. Voltage drops off proportionally

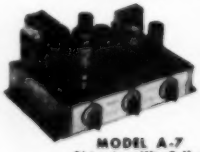
Every experimenter needs a good power supply for electronic setups of all kinds. This unit has been expressly designed to act as a HV supply and a 6.3 V filament voltage source. Voltage control allows selection of HV output desired (continuously variable within limits outlined), and a Volts-Ma switch provides choice of output metering. A large plainly marked and direct reading meter scale indicates either DC voltage output in Volts or DC current output in Ma. (Range of meter 0-500V D.C., 0-200 Ma. D.C.). Instrument has convenient stand-by position and pilot light.

Comes with power transformer, filament transformer, meter, 5Y3 rectifier, two 1619 control tubes, completely punched and formed chassis, panel, cabinet, detailed construction manual, and all other parts to make the kit complete.

$29.50

Model PS-1 Ship. Wt. 20 lbs.

Heathkit ECONOMY . . . 6 WATT AMPLIFIER KIT



- Choice of 4-8-15 ohm output impedances.
- Response flat ± 1½ db from 30—20,000 cycles.
- 6 watts output.
- Good fidelity at low cost.
- Output tubes working in push pull.
- Volume, bass, and treble controls.
- Two separate inputs.

MODEL A-7
Shipping Wt. 8 lbs.

$14.50

The purpose of this kit is to provide to the kit builder a low cost amplifier with excellent fidelity. The circuit consists of four tubes with following functions: a 12SL7, one section working as an amplifier and one as a phase splitter, two 12A6 output tubes working in push pull, and a 5Y3 rectifier in a full wave rectifier circuit.

The unit operates from a husky power transformer, and has good output transformer with a choice of 4—8—15 ohm output impedances. (Speaker not included).

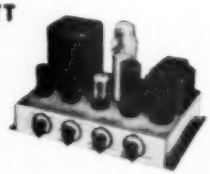
The kit provides excellent listening pleasure and the price is really low. Compare it with all others. You won't find a better buy.

MODEL A-7: For tuner and crystal phono inputs. Has two position selector switch for convenient switching to type of input desired.

Model A-7-A: Has a 12SH7 preamplifier stage with special compensation network for operation with reluctance phono input.

Shipping Wt. 9 lbs. **$16.50**

Heathkit HIGH FIDELITY 20 WATT AMPLIFIER KIT



MODEL A-8
Shipping Wt. 18 lbs.

$33.50

The A8 (or A-8A) is a high quality amplifier for those who want high fidelity output at moderate cost. Frequency response within ± 1db from 20-20,000 cycles. Distortion at 3db below maximum power output (at 1,000 cycles) is only 8%. Kit has a Chicago power transformer in drawn steel case and a Peerless output transformer with output impedances of 4—8—16 ohms. Bass and treble controls permit listener to select output with tonal qualities of his own liking.

The tube lineup is composed of a 6SJ7 voltage amplifier, a 6SN7 amplifier and phase splitter, two 6L6's in push-pull output and a 5U4G rectifier. All parts furnished (speaker not included) and the construction manual makes assembly easy.

MODEL A-8: For tuner and crystal phono inputs. Has two position selector switch for convenient switching to type of input desired.

MODEL A-8A: Features an added 6SJ7 stage (preamplifier) for operating from variable reluctance cartridge phono pickup, mike input, and either tuner or standard crystal phono pickup. A three position selector switch provides flexible switching. Shipping Wt. 18 lbs. **$35.50**

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Heathkit RECEIVER & TUNER KITS for AM and FM

$19.50

Model BR-1 Broadcast Model Kit covers 550 to 1600 Kc. Shipping Wt. 10 lbs.

Model AR-1 3 Band Receiver Kit covers 550 Kc. to over 20 Mc. continuous. Extremely high sensitivity. Shipping Wt. 10 lbs.

$23.50

TWO HIGH QUALITY Heathkit SUPERHETERODYNE RECEIVER KITS

Two excellent Heathkits. Ideal for schools, replacement of worn out receivers, amateur and custom installations.

Both are transformer operated quality units. The best of materials used throughout — six inch calibrated slide rule dial — quality power output transformers — dual iron core shielded. I.F. coils — metal cased filter condenser. The chassis has phono input jacks, 110 Volt output for phono motor and there is a phono-radio switch on panel. A large metal panel simplifying installation in used console cabinets is included. Comes complete with tubes and instruction manual incorporating pictorials and step-by-step instructions (less speaker and cabinet). The three band model has simple coil turret which is assembled separately for ease of construction.

Model FM-2
Ship. Wt. 9 lbs.

$22.50

TRUE FM FROM Heathkit FM TUNER KIT

The Heathkit FM Tuner Model FM-2 was designed for best tonal reproduction. The circuit incorporates the most desirable FM features — true FM.

Utilizes 8 tubes: 7E5 Oscillator, 6SH7 mixer, two 6SH7 IF amplifiers, 6SH7 limiter, two 7C4 diodes as discriminator, and 6X5 rectifier.

The instrument is transformer operated making it safe for connection to any type receiver or amplifier. Has ready wound and adjusted RF coils, and 2 stages of 10.7 Mc IF (including limiter). A calibrated six inch slide rule dial has vernier drive for easy tuning. All parts and complete construction manual furnished.

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	Heathkit Three Band Receiver Kit—Model AR-1			Heathkit Power Supply Kit — Model PS-1	
	Heathkit Amplifier Kit — Model A-7 (or A-7-A)			Heathkit Resistance Decade Kit — Model RD-1	
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	Heathkit Tube Checker Kit — Model TC-1			Heathkit A.C. VTVM-KIT — Model AV-1	
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TV Antenna Couplers

(Continued from page 49)

appear when this type of coupler is used. The great advantage of this circuit over the resistor pad is the fact that it will work well on fairly weak signals. The transformer losses are quite small and for all practical purposes a 1000 microvolt signal will produce almost 500 microvolts at each receiver, sufficient for good pictures. In the case of resistive pads a 1000 microvolt signal would hardly be usable. Oscillator radiation interference is present only when the two receivers are tuned to two different channels where the oscillator frequency of one falls within the r.f. channel of the other. As long as this condition is avoided, the transformer-type coupling unit shown in Fig. 3 can be recommended, especially for near-fringe areas. Although the bandwidth of this transformer is quite broad, some difference will be observed on different channels. One such commercial unit, using this circuit, is shown at the right in the photo, page 48. In installing such a device the two transmission lines going to the receivers should be kept separate. Under no circumstances should they be mounted alongside each other on a molding or wall. The *JFD* "TelePlex" unit, page 48, has the additional feature of a built-in lightning arrester which serves as protection for both TV sets. In order for this arrester to be effective, however, a good ground must also be provided.

Another type of commercial antenna coupling unit was described in detail in the article "Built-in Home TV System" appearing in the January 1952 issue of this magazine. In that unit the equivalent of transmission line circuits were used to get four isolated signals from a single antenna. The great advantage of this particular circuit lies in its low signal loss and it is, therefore, especially useful in weak signal areas. See page 48 (left). In a showroom where all receivers are close together and can be tuned to such channels as to avoid interference between sets, the *Brach* coupling is quite suitable. One drawback with this circuit is the fact that since all four receivers are effectively in series, oscillator radiation is often present.

There are several other antenna coupling units on the market and their principle of operation is usually based either on the transformer circuit shown in Fig. 3 or on transmission line theory.

Distribution Amplifiers

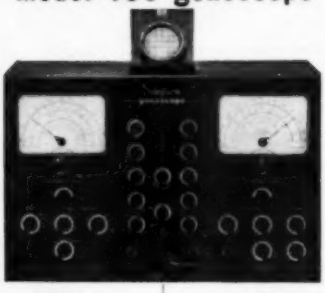
We have dealt with the problem of operating several receivers from a single antenna by assuming that a fairly strong signal is available. As we have shown, the solution to this problem is not too complex or expensive, but once the signal drops below about 1000 microvolts and more than two or four receivers must be fed, the installation becomes quite expensive.

If the signal strength varies between 50 and 500 microvolts at the antenna and two or three receivers are used, a booster can be used in conjunction with either resistive pads or one of the commercial coil-type couplers. In a location where only one station is received, possibly in both TV bands, a special broadband booster is required. The best solution in this instance would be to use one of the new weatherproof types that is permanently installed at the antenna. A transmission line is brought to a convenient spot near the first receiver and then the line is coupled to the different television receivers. The only function of the booster in this application is to provide sufficient signal strength to permit some attenuation. Before such an installation is made it will be helpful to know the gain of the booster over the channels being used and the amount of signal present at the antenna.

Where the signal is considerably less than 200 microvolts or a large number of receivers are to be operated, a specially engineered distribution amplifier and network is indicated. Page 48 (center) is the DAB 1 M distribution amplifier manufactured by *Blonder-Tongue Labs*. This unit is typical of many similar amplifiers such as the "Tacoplex" apartment house TV system, the "Intravideo," and many other multiple installation systems. Basically it consists of an amplifier section for each received channel. The signal can be obtained either from a common antenna or from individual antennas aimed at one particular station. Each signal is amplified according to its need and fed to a cathode follower. The output signals from the various cathode followers are carried by regular transmission lines to the different receivers. Since the signal leaving the amplifier is quite strong, it is possible to use resistor pads at each receiver to reduce oscillator radiation between sets. Another feature of such an amplifier is that although different stations are received at different signal strengths, the amount of amplification can be regulated so that signal strengths are all equal when they reach the receivers.

As we mentioned before, the cost of such an installation is quite high. A complete system for a 100 family apartment house may cost up to $10,000. A really large distribution system requires considerable engineering and involves test equipment and procedures not normally within the reach of the average service technician. But for some of the smaller installations where four to ten receivers are used it is possible and quite profitable for the technician to obtain a commercial distribution amplifier and do the entire job. Before embarking on any elaborate installation it will be wise to check local regulations on house wiring, fire ordinances, etc. Manufacturers' literature and detailed instructions should be followed closely with special consideration being given to local conditions. A detailed analysis should be made of the number and locations of

Simpson
model 480 genescope



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by service managers of leading manufacturers

These leading service managers agree the Simpson Model 480 Genescope is THE instrument for accurate testing and alignment of TV and FM receivers. It provides ALL the necessary signal sources and includes the famous Simpson high sensitivity oscilloscope completely equipped with a high frequency crystal probe for signal tracing. Also available without the oscilloscope as Simpson Model 479 TV-FM Signal Generator. For complete specifications see your Parts Distributor or write SIMPSON ELECTRIC COMPANY, 5200 W. KINZIE ST., CHICAGO 44.

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receivers, total signal required, length of lines, number and types of antennas, and the amplification necessary for each station. Be sure to list all these items, together with the impedance of the antenna and the different receivers, before deciding on a specific amplifier. All these factors are the cornerstone of a successful multiple TV installation and no amount of modification and adjustment later can make up for careful and exact planning. —30—

DIODES IN FM DETECTORS

By ARTHUR TRAUFFER

AFTER reading the series of articles "Crystal Diodes in Modern Electronics" currently running in RADIO & TELEVISION NEWS, experimenters and service technicians will want to try replacing tubes with germanium diodes in FM detectors and a.f.c. circuits.

In sets using a 6H6 in a Foster-Seeley discriminator, ratio detector, or a.f.c. circuit, quick and simple changeover to germanium crystals can be accomplished without disturbing any of the set wiring. See the photograph and the diagram of Fig. 1. Simply remove the base of an old 6H6 or other octal tube and mount the crystal diodes in the base as shown. The wire leads on the crystals are soldered into the tube base prongs. To use, simply pull out the 6H6 and plug in the crystals.

The writer uses a pair of 1N34's but it's best to use a 1N35 which consists of a pair of carefully matched 1N34's.

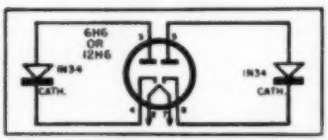
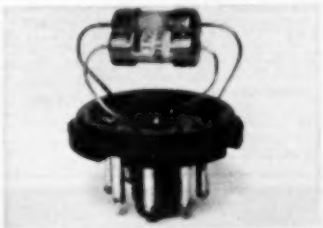


Fig. 1. Diagram showing how germanium diodes can be connected to the base of a 6H6, 6H6GT, or 12H6 octal tube.

This kink does not apply to the 6AL5 which has a non-removable base or to sets having tube heaters series-wired.

As explained by Mr. Armstrong in his series, better circuit balance is sometimes obtained by shunting a resistor across each crystal diode. In this case, simply parallel-mount the resistors, reaming the bottom openings in the tube base prongs, if necessary, to accommodate the extra lead. —30—

How converted socket looks when the germanium crystal diode is in place.



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Only $19.95 buys a full 15" 20 watt coaxial PM speaker, with built-in high pass filter. Rugged enough to stay 8 ohm output on radio or amplifier. Response from 30 to above 17,500 CPS. Good bass response. A lucky purchase makes this price possible. Full 32 oz. magnet in the woofer. 5" tweeter. Model P-15-S. Ship. wt. 11 lbs. Sale price, **$19.95.**

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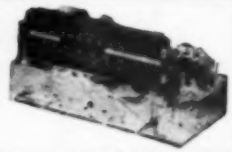

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McGee's new 1951 model 12 tube FM/AM chassis. Latest design with phono inputs for all types of record players, crystal or G.E. variable reluctance. Receives standard broadcast 530 to 1700 kc and FM 88 to 108 Mc. Wide range audio response (down 3 db at 15 cps and bass boost tone control. Long antenna for broadcast and 300 ohm line for FM. Built in power supply for 50 watt booster amplifier. Attractive tilted front chassis size, 13½x9 high and 9" deep. Shipping weight 20 lbs. **Stock No. 7-CR.** Made to sell at a much higher price. McGee's sale price is **$64.50**, less speaker output transformer & tubes. **7-CR** chassis with our 12" coaxial PM, 15 watt, **$74.95.**

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2—12" P.M. SPEAKERS
$200.00 VALUE WALNUT CABINET
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Buy this combination offer and have a fine radio-phono combination for less than the value of the cabinet alone. This beautiful walnut cabinet was intended for a Capehart $800.00 combination and is the finest possible, furniture quality cabinet workmanship. 37" high, 40" wide and 21" front to back. Hinged top lifts in two sections. 23½" lid covers the changer compartment and 14½" covers the radio compartment. Changer mounting panel is furnished and the panel is shipped ready cut to fit Espey 7-C chassis. Two heavy duty 12" PM speakers are furnished. Espey 7-C chassis and a General Electric 3-speed changer with G.E. variable reluctance cartridges. Stock No. MED-375 cabinet. Espey 7-C chassis, 2 speed G.E. changer and 2 12" PM speakers, **$104.00.** Sale price, **$179.95.**

3 speed VM automatic changer with G.E. variable reluctance turnatouat cartridge furnished for $15.00 extra. Shipping weight 200 lbs. Shipped via truck, rail or express only.

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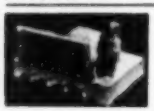

HALLICRAFTERS S-78 11-TUBE FM-AM CHASSIS

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Hallicrafters S-78, 11-tube AM-FM radio receiver chassis, with push-pull 6K6 high fidelity audio system. A new model chassis for custom installation. Full range tone control, with tone knob. Input for phonograph pickup. Output impedance 4, 8 ohm and 500 ohm connection. Chassis size 12½ x 10 x 7¾ high. Knobs and escutcheon plate not furnished. Receives standard broadcast 540 kc to 1600 kc and FM 88 to 108 mc. Shipping weight, 25 lbs. Model S-78, priced less speaker at **$89.50** net. Model S-78 11-tube AM-FM chassis with 12" coaxial PM speaker, both for **$99.50.** S-78 with 15" coaxial PM speaker, both for **$107.00.**

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Beautiful, top quality, walnut combination radio-phono cabinet. 42" high, 44" wide and 22" deep. Made for Capehart's finest combination. Highly polished hatched walnut finish. Cabinet top is 1¼" thick. This cabinet weighs approximately 180 lbs. Both the radio and changer compartments and speaker grill have hinged doors. Radio compartment on the right-hand side is 14" high and 17½" wide. Made to mount chassis vertically. The changer compartment is 14" high and 26½" wide. Large enough to hold any record changer or recorder mechanism. Front 10" of top over the changer compartment is hinged to fold back for easy access to the changer. Both radio and changer compartments come with metal panels. Speaker baffle is cut for a 12" speaker and the compartment is covered with perforated metal. Shipping weight, 275 lbs. Stock No. K-275. Capehart combination cabinet. Net price, **$99.95.**

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1D7	.70	6C6	.60	7A8	.60	1C6	.60
1D8	.70	6CB6	.60	7B7	.70	1C7	.70
1E5	.60	6CD6	1.00	7B8	.70	1D5	.70
1E7	.70	6CG7	.60	7C5	.60	1D7	.70
1F4	.60	6CM7	.70	7C6	.60	1D8	.70
1F5	.60	6D6	.50	7C7	.70	1E5	.60
1F6	.60	6D8GT	.70	7E5	.70	1E7	.70
1G4	.60	6DA6	.60	7E6	.70	1F4	.60
1G5	.60	6DE6	.60	7E7	.70	1F5	.60
1G6	.60	6DE7	.70	7F7	.70	1F6	.60
1H4	.60	6DK6	.60	7F8	.70	1G4	.60
1H5	.60	6DL6	1.00	7G7	.70	1G5	.60
1J6	.60	6DQ6	1.00	7H7	.70	1G6	.60
1L4	.60	6DT6	.60	7J7	.70	1H4	.60
1L5	.60	6E5	.60	7K7	.70	1H5	.60
1L6	.60	6E6	.60	7L7	.70	1J6	.60
1N5	.60	6E8GT	.70	7N7	.70	1L4	.60
1P5	.60	6F4	.60	7Q7	.70	1L5	.60
1Q5	.60	6F5	.60	7S7	.70	1L6	.60
1R5	.60	6F6	.60	7V7	.70	1N5	.60
1S4	.60	6F6GT	.60	7W7	.70	1P5	.60
1S5	.60	6F7	.60	7X7	.70	1Q5	.60
1T4	.60	6F8G	.60	7Y4	.70	1R5	.60
1U4	.60	6G6G	1.00	12A6	.60	1S4	.60
1U5	.60	6G8G	1.00	12AT6	.60	1S5	.60
1V2	.60	6H4GT	.60	12AT7	.60	1T4	.60
1V6	.60	6H6	.60	12AU6	.60	1U4	.60
2A3	1.00	6J5	.60	12AU7	.60	1U5	.60
2A5	.60	6J5GT	.60	12AV6	.60	1V2	.60
2A6	.60	6J6GT	.60	12AV7	.60	1V6	.60
2A7	.60	6J7GT	.60	12AX7	.60	2A3	1.00
2B7	.60	6K6GT	.60	12BA6	.60	2A5	.60
2C26	.60	6K7GT	.60	12BE6	.60	2A6	.60
3A4	.60	6K8GT	.60	12BH7	.60	2A7	.60
3A5	.60	6L6G	1.00	12BY7	.60	2B7	.60
3A8	.60	6L6GT	.60	12C8	.60	2C26	.60
3B7	.60	6L7	.60	12J5GT	.60	3A4	.60
3B8	.60	6L7GT	.60	12J7GT	.60	3A5	.60
3C6	.60	6N7GT	.60	12K7GT	.60	3A8	.60
3D6	.60	6N8	.60	12K8GT	.60	3B7	.60
3Q4	.60	6P5GT	.60	12Q7GT	.60	3B8	.60
3S4	.60	6Q7	.60	12SA7GT	.60	3C6	.60
5U4G	.60	6Q7GT	.60	12SC7GT	.60	3D6	.60
5V4G	.60	6R7GT	.60	12SF7GT	.60	3Q4	.60
5X4G	.60	6S7GT	.60	12SG7GT	.60	3S4	.60
5Y3GT	.60	6SA7GT	.60	12SH7GT	.60	5U4G	.60
6A3	.60	6SC7	.60	12SJ7GT	.60	5V4G	.60
6A4	.60	6SC7GT	.60	12SK7GT	.60	5X4G	.60
6A5G	.60	6SF5GT	.60	12SL7GT	.60	5Y3GT	.60
6A6	.60	6SF7	.60	12SN7GT	.60	6A3	.60
6A7	.60	6SF7GT	.60	12SQ7GT	.60	6A4	.60
6A8G	.60	6SG7	.60	12SR7	.60	6A5G	.60
6AB4	.60	6SG7GT	.60	12SR7GT	.60	6A6	.60
6AC7	.60	6SH7	.60	12Z3	.60	6A7	.60
6AG5	.60	6SH7GT	.60	12Z3GT	.60	6A8G	.60
6AG7	.60	6SJ7	.60	25A7GT	.60	6AB4	.60
6AK5	.60	6SJ7GT	.60	25L6GT	.60	6AC7	.60
6AL5	.60	6SK7	.60	25Z5	.60	6AG5	.60
6AQ5	.60	6SK7GT	.60	25Z6GT	.60	6AG7	.60
6AT6	.60	6SL7GT	.60	25Z6GT	.60	6AK5	.60
6AU6	.60	6SN7GT	.60	35A5	.60	6AL5	.60
6AV6	.60	6SQ7	.60	35L6GT	.60	6AQ5	.60
6B4G	.60	6SQ7GT	.60	35W4	.60	6AT6	.60
6B8	.60	6SR7	.60	35Y4	.60	6AU6	.60
6B8G	.60	6V6GT	.60	35Z3	.60	6AV6	.60
6BA6	.60	6W4GT	.60	35Z5GT	.60	6B4G	.60
6BA7	.60	6X4	.60	50L6GT	.60	6B8	.60
6BC5	.60	6X5GT	.60	80	.60	6B8G	.60
6BE6	.60	6X8	.80	117L7GT	1.40	6BA6	.60
6BF6	.60	6Y5G	.60	117Z3	1.00	6BA7	.60
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VM model 406, deluxe 3 speed automatic record changer. Plays them all. Intermixes records of the same speed. Equipped with a flip over crystal pickup with twin needles. Base size, 14¼x14. Shipping weight 12 lbs. VM-406. Net price **$22.95.**

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Another tremendous McGee record changer scoop. Only 500 to sell. General Instrument, 3 speed automatic record changer with standard crystal cartridge and all purpose permanent needle. Brand spanking new, the first offering of a 3 speed changer at less than $30.00. We purchased a large quantity and pass our saving on to you. Stock No. GI-33SH. Sale price **$19.95** each. Price to the small manufacturer in lots of 48 or more, **$10.50** each.

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50-watt super quality high fidelity output transformer. Matches push-pull parallel of push-pull 6L6 tubes to 4 8 16 ohm voice coil. Also 80 and 250 ohm line. Very efficient winding construction with 140 ohms total resistance in primary, and 8 ohm voice coil tap only 2 ohms. This output transformer wastes a minimum amount of audio power due to heat loss within the transformer. Ideal for public address amps. Stock No. 50-20, net weight 31½ lbs. Bargain price **$7.50** ea., 2 for **$13.95.**

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Model A-403 High fidelity output transformer. Why pay $20 or $30 for an output, when our A-403 is available at $7.95? Impedance, 6000 ohms plate to plate for PP 6L6 or 6V6. 10% feedback winding. 4-8-15-250 and 500 ohm secondary. Mounted in a potted case. Net weight 6 lbs. Recommended for all amplifiers up to 34 watts.

10" SPEAKER AND BAFFLE $6.95

Stock No. CA-10. Tan leatherette covered plywood sled type wall baffle, plus 10" Permadyn 8 ohm P.M. speaker. Only a few hundred to sell at **$6.95** each, or **$6.25** each in lots of 3 or more.

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50-WATT BOOSTER AMPLIFIER—$39.95

25-Watt Horn $28.95 — 50-Watt Booster $39.95 — 2-Mike Pre-Amp. $10.00 Extra.

50-WATT BOOSTER A sensational value. 50 watt booster amplifier with push-pull 6L6 output tubes. Uses 6L6 output tubes. Connect to your present amplifier as a booster or use with the PR-2X Pre-amp to add the use of 2 mikes and one low level input. The booster amplifier has one input jack and will mix 1 volt input gives 50 watts of audio. Booster has a 6 lb. potted case to hold fidelity output transformer that matches speaker with 4-8-16 ohm voice coil, also 60 ohm and 250 ohm line. Booster has a 225 mill power supply with 5U4 rectifier tube. Set includes tubes 6L6, 7N7 and 5U4. The two variable controls are for master volume control and base boost tone control. Size 8 x 6½ x 14½. Stock No. PA-55X. Shipping weight 26 lbs. Sale price **$39.95** ea.

2-MIKE PRE-AMP. Pre-amplifier plugs in directly to the PA-55X Booster amplifier, it enables use of 2 Crystal or Dynamic Mikes plus one low level input. Furnished with 4 foot cables and plugs for remote control of the 55 watt Booster Amplifier. Small chassis size 3 x 3½ x 4". Stock No, PR-2X, with tubes 7F7 and 7N7. Net price **$10.00** ea.

25-WATT HORN 25-Watt Driver and 31½-foot air column re-entrant Trumpet. The standard type trumpet and driver you see the most. Drivers are 100% weatherproof, horn is spun aluminum, offered to you at a considerable savings. Stock No. MA-33. Shipping weight 20 lbs. Net price **$28.95.**

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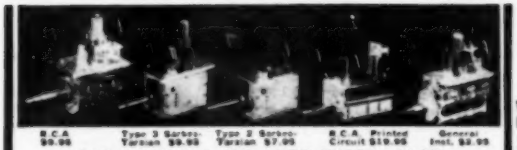

R.C.A. $9.95 | Type 3 Sarkes-Tarzian $9.95 | Type 2 Sarkes-Tarzian $7.95 | R.C.A. Printed Circuit $19.95 | General Inst. $2.95

RCA TV FRONT END WITH TUBES $9.95

Terrific buy on this RCA TV tuner. We have a limited quantity of the famous original 201K1, 13 channel completely wired and tested TV front end tuners. Ready to connect to your TV video I.F. strip. Offered at a sacrifice. Price was originally $44.00. Now only $9.95 each, with tubes. Your choice of channels with this No. 86 A 13F TV front end tuner. Shaft length 3⅜" from base of tuner. Converter coil type for separate sound, as used in the famous 630 chassis. Net price $9.95 each, two for $19.00, complete with 3 6J6 tubes.

SARKES-TARZIAN TYPE 3-TUNER WITH TUBES $9.95

This popular Sarkes-Tarzian TV front end is widely used today. 12 channel rotary type switch with individually tuned coils. Price includes a schematic diagram and 3 tubes; 6C4 osc., 6BH6 RF and 6AG5 mixer. Regular factory cost is twice our price. Each tuner and its own tube sockets are wired, ready to hook up to a video and sound IF strip. May be used with either inter carrier or separate sound IF circuits. Built in fine frequency control. Shipping weight 4 lbs. Type 3 Sarkes-Tarzian TV tuner with tubes. Net price $9.95. Type 3 tuner and 205-XX video coil kit, both for $16.95.

3-TUBE TUNER SCOOP—$2.95 LESS TUBES

Type 4 Sarkes-Tarzian 12 channel TV tuner. Requires 2-6AG5 or 6BC5 and a 12AT7. Has ¼" diameter shaft, 2⅝" long. Has screwdriver fine tuning adjustment. It differs from other tuners in that it has no concentric fine tuning shaft over the channel selector shaft. Very fine for experimental use, building field strength meters, etc. Sarkes Tarzian 4. TV tuner. Sale price only $2.95.

RCA 12-CHANNEL PRINTED CIRCUIT TV TUNER $19.95

Latest design RCA 12 channel printed circuit TV tuner. Rotary switch with snap-in printed circuit strip principle. This popular tuner used by Hallicrafters in inter-carrier circuit sets. Shaft length 3⅜". Built in fine frequency control. Price includes tubes, 6J6 and 6CB6. A terrific value at $19.95 each.

GENERAL INSTRUMENT TV TUNER, LESS TUBES $2.95

Completely wired, 12 channel selector incorporating fixed inductance and variable capacitance. Converter output transformer is matched. To be coupled direct to separate sound and video IF's, 3 6J6 tubes are required. Built in fine frequency control. Original cost over $20.00. Weight 4 lbs. Have been in sets, but guaranteed to be a good value. Stock No. GI-13UT. General Instrument TV tuner, less tubes. Net price $2.95 each.

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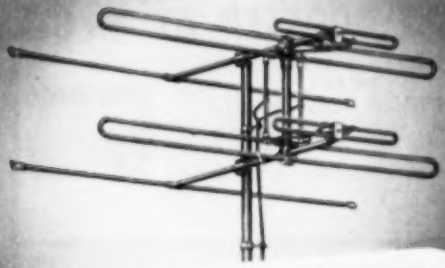

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AMPHENOL

Spot Radio News

(Continued from page 18)

cases and on an entirely voluntary basis, related to the dispatching of trains and other utilities, the relaying of orders for emergency food supplies, the reporting of hourly weather observations, the bridging of gaps in commercial telegraph facilities for handling emergency and death messages and the relaying of personal messages regarding the health and safety of individuals . . ."

THE SPRAWLING GROWTH of radio, emphasized throughout the report and in a letter of transmittal to Congress, was described as having placed an unusual burden on the Commission's staff, seriously affecting its operation. According to Wayne C. Coy, the manpower problem has become extremely acute and additional funds are urgently needed to recruit help. He hoped, therefore, that the increase in the budget, indicated in President Truman's message, would be allowed. Specifically, about a twenty-four percent increase or about $2 million more will be needed, noted the former FCC chairman. Senator Edwin Johnson revealed an intense interest in the Commission's problem and indicated that he will argue for more funds so that the FCC can do a . . . "bigger job."

THE FREEZE LIFT, which should be officially an item of the past when this column appears in print, is expected to inaugurate an exciting era for telecasters and viewers.

One of the features of the lift will be the allocations for eventually over 1500 new stations on the ultra-high band, or Channels 14 to 83. This new projected home for TVcasters has prompted many to make enthusiastic predictions on television's future. In one such forecasting mood, *Zenith's* Vice-President H. C. Bonfig said, during an address in Kansas City, Missouri: "Crystal gazing is always a rash venture, but on the basis of what we know about u.h.f. and what we know about the ability of engineers to discover new advantages in new frequencies, I make the prediction that the stations on the u.h.f. channels are going to render as good or better all-round service than the v.h.f. stations now in operation."

In Washington, during a consulting engineering seminar, a striking interest was also exhibited in the potentialities of the higher bands. So keen was this ultra-high interest that the manufacturer who sponsored the meeting decided to announce the possibilities of the new channels in page ads in the metropolitan dailies. And during the sessions, it was disclosed that three types of converters would be available during the early fall for high-band pickup: single- and two-station, and all-channel converters, with prices ranging from about $10 to $50. It was also said that all new receivers would be able to accommodate the converters or combination very-high/ultra-high 16-station tuner heads that will be produced soon, too. Consultants and industry specialists at the meeting also predicted that there would be a supply of transmitters and auxiliary gear available for the new stations scheduled to operate on the low or new high bands. It was believed that as many as 22 new v.h.f. stations may go on the air before the year is out and perhaps a few on the higher bands. Next year should see at least 60 u.h.f. stations operating.

COLOR IN TV, which with the issuance of the Wilson order curbing set production, returned quietly to conservative labs and sombre meeting rooms, roared back to the headlines shortly after the New Year holidays, when NPA called a meeting to reappraise the clamp ruling.

The return visit of industry to a color conclave was, in part, inspired by an exchange of correspondence between Defense Chief Charles Wilson and Senator Edwin Johnson, who had felt that the original desist order was . . . "an unwarranted crippling blow aimed directly and specifically at color television." In the Senator's opinion . . . "Every conceivable legal maneuver and technical roadblock has been used in the past years to delay the availability of color television to the public . . ." and the curb ruling pro-

vided the halt result that he and others were interested in avoiding. Declaring that the order was an attempt to regulate the end product, the fiery Senator asked Wilson: "What difference is there to the defense effort once you have made the allocation of the materials, as to whether or not the materials are used for black and white or color?"

Roaring statements sparked the recall meeting. In a specially-prepared ten-page document, *RCA's* Board Chairman David Sarnoff accused *CBS* of failure to bring color to the public at moderate prices, as forecast at Commission hearings. He noted that *Columbia* had promised that color sets would be available at about $300, but instead they offered sets . . . "with a ten-inch picture tube . . . at a price of more than $600 for the set including installation, warranty and taxes." Adding that this increase had been made in a market in which prices on black and white sets were dropping rapidly, Mr. Sarnoff said that even . . . "*CBS* cut prices on its own . . . sets by 20 per-cent." The statement then noted that the adapters promised by *CBS* were never put on the market. And, declared Mr. Sarnoff . . . "Instead of converters selling for at $110 to $150 as . . . promised . . . *CBS* announced in July of '51 that it intended to put slave converters on the market which would sell for about $250. These converters, likewise, never reached the market."

Charging too that the sequential proponents also failed in their broadcast promises, he noted that . . . "*CBS* never broadcast even half of its promised regular schedule of 20 hours of color a week by September 25, the end of the three-month period."

Discussing the *CBS* request for a quarter-of-a-million fractional horsepower motors for '52, which were to be used to turn the wheels in the mechanical color sets, Mr. Sarnoff indicated that it was generally known that these motors . . . "have been in short supply as a result of defense work." In any event, the board chairman added . . . "Even according to the optimistic prediction of *CBS'* manufacturing subsidiary prexy . . . *CBS* only intended to turn out color television sets at the rate of 80,000 a year. . . . And it is doubtful whether . . . *CBS* could have reached this figure during '52, even if it were allotted all the material it asked for. . . . It is obvious that *CBS* made an unreasonable request, which it was expected, NPA would be obliged to deny."

In reply, *CBS* Prexy Frank Stanton described the contributions his company had made to color which . . . "cannot be obscured by unprincipled attacks." In the interest of the public, he added, if . . . "anyone thinks that new color television standards should be adopted . . . let him take these issues before the FCC . . . where they can be resolved by testimony under oath and by actual demonstration of performance."

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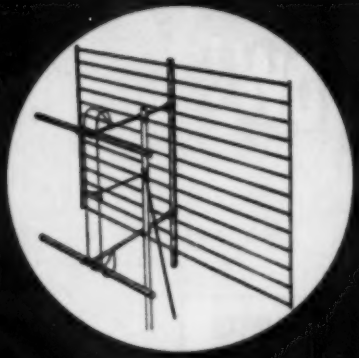

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Appearing on behalf of *Chromatic Television Labs*, a *Paramount Picture* subsidiary interested in the *Lawrence* tube, Barney Balaban, *Paramount* prexy, said that the curb order . . . "penalizes efforts made to advance the electronic art under a system of free competition . . . and needlessly frustrates progress in TV."

While no decision had been made by NPA, as this column was being prepared, it was believed that the curb order would be tempered to permit the processing of theater and commercial color-system equipment, provided that this can be done with allotted materials. The ruling may also be rewritten to permit the manufacture of home color sets, if such sets can be made with components now available for general black and white chassis production. There was doubt that permission to make color sets would interest anyone, since materials are too short even for normal black and white model manufacture. However, the theater angle may appeal to many, for it might be possible to produce a few of the larger screen equipments with available parts and material; this should interest movie exhibitors and provide a means of evaluating the audience-building possibilities of such projection.

BROADCASTING on the sight-and-sound, and sound fronts, will this year, a presidential-election year, strike a new high in listener interest. Commenting on this, former FCC Chairman Wayne Coy noted, during an address in Cleveland: "During the last campaign, TV had an impact when there were only 1-million sets in use. Imagine what the impact will be in this fateful year of 1952 when there are 16-million sets in use and perhaps 60 per-cent of the American families looking in—seeing and hearing and understanding more about what goes on in the conventions than most of the spectators right in the hall. . . . It is already apparent that the expenditures for political time during this year will break all records. . . . In bringing listeners and viewers a well-rounded presentation of the convention activities and of the campaigns, radio stations—both aural and visual—will perform one of their most valuable services."

Declaring that during this year, more than ever before, the public will really begin to deeply appreciate the advantages offered by TV, the Commission's former chief said that television . . . "will bring to the fore the historic significance of two precious freedoms which are the common heritage of all of the American people; the freedom to look and the freedom to listen. . . . Only through the full exercise of these freedoms can the American people have in their broadcasting system the truly democratic instrument of information that their democratic society requires." Truly, an illuminating assessment of the power of television. . . . . L.W.

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1. Connect Bar Generator to Antenna Post of any TV Receiver.
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RESULT: A stable never-shifting vertical or horizontal pattern projected on the screen of the TV receiver under test.

Power Supply: 105-125 Volt 60 Cycles. Power Consumption: 20 Watts. Channels: 2-5 on panel, 7-13 by harmonics. Horizontal lines: 4 to 12 Variable. Vertical lines: 12 Fixed. Vertical sweep output: 60 cycles. Horizontal sweep output: 15,750 Cycles.

TV Bar Generator comes complete with shielded leads and detailed operating instructions. Only ..... **$39.95** NET

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The Model 660 comes complete with coaxial cable test lead and instructions ..... **$42.95** NET

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PHONO-EQUALIZER CHART

By CHARLES P. BOEGLI

INASMUCH as new data has become available since the publication of the author's article, "An Improved Equalizer-Preamp" in the April 1951 issue, it is now possible to revise the equalizer design chart which accompanied the original article.

The new information includes the establishment of a standard playback curve by the Audio Engineering Society and the publication of recording characteristics by RCA Victor. Of particular note is the fact that the new RCA Victor recording curve, which is the same for all speeds, is identical to the AES curve. The older RCA curve is sufficiently close to the new one that an equalizer to correct the new characteristics will be satisfactory for older RCA records. The set of equalizers previously designed for RCA records is superseded in the table by the simple AES equalizer.

It should also be noted that London FFRR 33⅓ rpm records follow the NAB characteristic, the previous table was in error on these discs. The 78 rpm FFRR records, both Decca and London, follow the previously published curve.

The final addition to the chart is an equalizer for a flat characteristic with a 350 cps bass turnover. This frequency lies midway between 250 and 500 cps and the new equalizer will be found acceptable in most cases. The other two, the 250 and 500, are included in the table for those who wish them, but there would be little point in including all three in any amplifier.

One worthwhile improvement has been incorporated into the construction of the preamp by several builders. It consists in mounting the equalizers on a three-gang rotary switch with the gangs properly spaced to avoid overcrowding. In this manner a desirable increase in compactness is obtained.

The potting of the equalizers, if desired, may be carried out not only with hard microcrystalline wax but also with any other suitable compound such as ceresine wax or a commercial potting compound.

Equalizers of the type described can be used not only in the small preamplifier which was the subject of the previous article, but also following a triode stage in any amplifier.

The assistance of T. B. Couch of New Rochelle, N. Y. and Willis Cox of Cincinnati, Ohio in providing helpful information on response curves and construction data is hereby acknowledged with gratitude.

REVISED EQUALIZER CHART

EQUALIZER CHARACTERISTIC	EQUALIZER DESIGN	GOOD COMPENSATION FOR	ACCEPTABLE COMPENSATION FOR
(A) Flat 250 cps turnover		H.M.V. British Columbia	
(B) Flat 500 cps turnover		Capitol-Telefunken Most European and early American	
(C) Flat 350 cps turnover			All discs for which (A) and (B) were designed
(D) AES 400 cps bass turnover, 6 db/octave treble emphasis above 2800 cps		RCA Victor 33⅓ rpm RCA Victor 45 rpm Late RCA Victor 78 rpm	Earlier RCA Victor 78 rpm (see text)
(E) NAB 500 cps bass turnover, 6 db/octave treble emphasis above 1590 cps		Most late American discs except as noted elsewhere. London FFRR 33⅓ rpm	Earlier Columbia 78 rpm Columbia 33⅓ rpm
(F) 400 cps bass turnover, 3 db/octave treble emphasis above 3000 cps		Decca and London FFRR 78 rpm	R, 820,000 ohms or over R, 33,000 ohms R, Approx. 1.5 x R, R, 22,000 ohms R, Approx. 1.2 x R, R, 39,000 ohms R, Approx. .8 x R, R, 27,000 ohms R, 5600 ohms R, 150,000 ohms C, .02 ufd. C, .01 ufd. C, .0015 ufd. C, .003 ufd. C, 250 uufd.
(G) 300 cps bass turnover, 6 db/octave treble emphasis above 1590 cps		Earlier Columbia 78 rpm	
(H) 500 cps bass turnover, constant velocity below 100 cps, 6 db/octave treble emphasis above 1590 cps		Columbia 33⅓ rpm	

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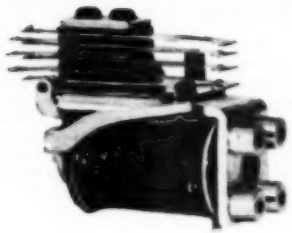

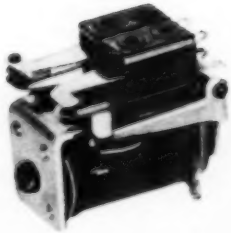

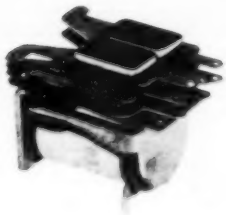

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R-850	12 VDC.	450	1A @ 1.5 AMP.	ADVANCE 1601	1.50
R-379	19/27 VDC.	250	2A @ 1.5 AMP.	ADVANCE 1605	1.65
R-694	24 VDC.	300	1A @ 5 AMP.	ADVANCE 1601A	1.50
R-935	28 VDC.	1000	1C @ 1.5 AMP.	ADVANCE 1603S	1.65
R-572	24 VDC.	256	1C	AIRCRAFT RADIO CORP.	1.25
R-857	24 VDC.	260	1 MAKE BEFORE MAKE	AIRCRAFT RADIO CORP. 9453	1.75
R-912	4/5 VDC.	20	3A-1C CERAMIC	ALLIED TRK50	1.45
R-291	6 VDC	5	1A	ALLIED 73A71	1.25
R-921	6.7 VDC.	18	1A Dbl. Brk. @ 10 amp.	ALLIED CRX 11	1.45
R-738	12 VDC.	60	3A	ALLIED TX3A	1.20
R-922	12 VDC.	75	1A Dbl. Brk. @ 10 amp.	ALLIED CRX 13	1.45
R-144	12 VDC.	228	1A	ALLIED D-283486	1.45
R-696	24 VDC.	230	1A @ 8 AMP.	ALLIED 55837	2.00
R-145	18/24 VDC.	250	2A CERAMIC	ALLIED 7252	1.45
R-723	24 VDC.	280	1C	ALLIED 7251	1.50
R-298	21 VDC.	300	1A	ALLIED CB-5	1.25
R-296	21 VDC.	300	1A	ALLIED CA-5	1.25
R-586	21 VDC.	300	1A & 1C	ALLIED 73A-69	1.25
R-142	24 VDC.	400	2C	ALLIED 73A50	1.50
R-785	24 VDC.	200	2C @ 10 AMPS.	AUTO. ELECT. ZM-37169-1	2.00
R-375	24 VDC.	200	2A heavy duty	AUTO. ELECT. M-87063-1	1.75
R-373	12/20 VDC.	225	1A split	AUTO. ELECT. SQA	2.50
R-370	12 VDC.	75	1C	AUTO. ELECT. MANKATO R-25	2.30
R-607	24 VAC.	INT.	1A	AUTO. ELECT. MANKATO R-45-D	1.20
R-606	24 VAC.	INT.	1A & 1B	AUTO. ELECT. MANKATO R-45-F	1.20
R-605	24 VAC.	INT.	3A	AUTO. ELECT. MANKATO R-45-G	1.20
R-374	24 VDC.	300	2A heavy duty	BETTS & BETTS RAC-15AS	1.75
R-728	6 VDC	30	1A	CLARE A-26690	1.25
R-149	6-8 VDC.	45	1B	CLARE A-20545	1.50
R-732	12 VDC.	120	1A	CLARE A-25454	1.45
R-281	12 VDC.	126	2A	CLARE A-13415	1.25
R-347	18/24 VDC.	300	1A	CLARE A-19469	1.10
R-376	24 VDC.	300	1A	CLARE K	1.25
R-818	18/24 VDC.	300	1B	CLARE A-8058	1.30
R-133	24 VDC.	300	NONE	CLARE A-20368	.75
R-348	18/24 VDC.	300	2A	CLARE A-16734	1.15
R-138	24 VDC.	300	4A	CLARE A-16260	1.45
R-349	18/24 VDC.	300	1C	CLARE B-16947	1.25
R-377	24 VDC.	300	1C	CLARE B-22441	1.45
R-132	24 VDC.	300	2C	CLARE	1.50
R-731	24 VDC.	300	2C	CLARE A-16265	1.55
R-492	24 VDC.	300	4C 1A	CLARE	1.95
R-626	24 VDC.	400	1A @ 5 AMPS.	CLARE A-22717	1.55
R-786	60 VDC.	1300	2C	CLARE A-12408	2.00
R-415	60/85 VDC.	1300	2A	CLARE K	1.95
R-371	2 VDC	30	1C Ceramic	COOK 418	1.75
R-755	24 VDC.	300	1A	COOK 55340	1.45
R-150	6 VDC	30	1A	E-Z ELECTRIC	1.50
R-893	14 VDC.	150	1A, 1C	G. E. 55526	2.50
R-895	14 VDC.	150	2A, 1B, 1C	G. E. 55531	2.50
R-896	24 VDC.	260	2A	G. E. 55589	2.50
R-959	24 VDC.	747	2C	GUARDIAN 36761	1.50
R-693	2/6 VDC.	125	1C @ 3 AMP.	LEACH P-501424	1.20
R-947	12/24 VDC.	320	1C @ 3 AMP.	LEACH P-3	1.25
R-692	6/24 VDC.	1280	1C @ 3 AMP.	LEACH P-3	1.35
R-856	18/24 VDC.	300	1B	PAUL HENRY 1010	1.45
R-913	6 VDC	20	3A, 1C CERAMIC	PRICE BROS.	1.45
R-915	12 VDC.	70	1A Dbl. Brk. @ 10 amp.	PRICE BROS.	2.00
R-148	12 VDC.	100	2C & 1B	PRICE BROS.	1.85
R-222	12 VDC.	100	2A	POTT & BRUM.	1.00
R-834	6 VDC	20	3A, 1C	R&M	1.45

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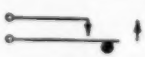
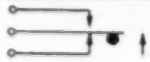


Form A—"Make" (Single Throw, Normally Open)

Form B—"Break" (Single Throw, Normally Closed)



Form C—"Break-Make" (Double-Throw)

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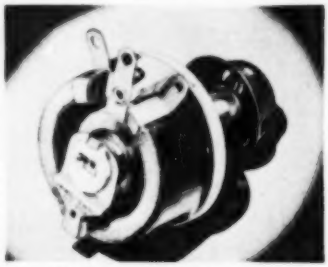
WHAT'S *New in Radio*

For additional information on any of the items described herein, readers are asked to write direct to the manufacturer. By mentioning RADIO & TELEVISION NEWS, the page, and the issue number, delay will be avoided.

NEW RHEOSTAT

Tru-Ohm Products, 2800 Milwaukee Avenue, Chicago 18, Illinois, has developed a new rheostat which provides smooth variation of resistance under the most adverse conditions and insures



dependable service by virtue of its all ceramic-metal construction.

An extra deep core, on which resistance wire is toroidally wound, means a more conservative power rating. The rheostat is available in either uniformly or taper wound models with a standard tolerance of 10 per-cent.

WILLIAMSON-TYPE AMPLIFIER

The Heath Company, Benton Harbor, Michigan, has added a Williamson-type amplifier and matching preamplifier to its extensive line of kits.

The amplifier and power supply kit (WA-A1) uses two 6SN7GT's, two 807's, and one 5V4G. It has a frequency response within 1 db from 10 cycles to 100 kc. Intermodulation distortion at a 5 watt output is .5% using 60 and 3000 cycles. The output impedance is 4, 8, or 16 ohms, and the input voltage for a 5 watt output is 1.2 volts across 470,000 ohms. Power requirements are for 105-125 volts, 50 or 60 cycles, 120 watts. The amplifier and power supply

chassis each measure 7" high, 5½" wide, and 11" long.

The matching preamplifier unit (WA-P1) uses one 12AY7 or 12AX7 and one 12AU7. There are three switch-selected inputs, *i.e.*, two low gain for crystal pickup and tuner and one high gain for magnetic pickup. It features a switch-selected turnover for 78 rpm and LP on the high gain channel. The bass and treble tone controls will boost or cut a maximum of 15 db at 20 cycles and 20 kc. respectively. Power requirements are 220 volts d.c. at 6 ma. and 6.3 volts at 600 ma. Dimensions, less shafts and knobs, are 2¼" high, 10¼" wide, and 7¼" deep.

RANDOM-NOISE GENERATOR

General Radio Company, 275 Massachusetts Avenue, Cambridge 39, Massachusetts, has developed a new "random-noise generator," the Type 1390-A.

A gas-discharge tube operated in a magnetic field is the noise source. Two stages of amplification and suitable filters make it possible to have an open-circuit output voltage of one volt on the three frequency ranges, extending from 30 cycles to 20 kc., 500 kc., or 5 mc. The normal, or Gaussian distribution of amplitudes is very good with only moderate clipping on the 500 kc. and 5 mc. ranges.

A panel output control and voltmeter

is provided on the generator and, where relatively low levels are required, an external Type 700-P1 voltage divider can be used.

PRINTED CIRCUITS

Stupakoff Ceramic and Manufacturing Company, Latrobe, Pa., has announced the development of a series of printed electrical circuits for various applications.

A number of standard circuits is currently available, some of them incorporating as many as six separate resistors and condensers in a permanent circuit. Special circuits can be made to meet individual requirements.

A four-page booklet, Bulletin 1151, describes these new units in some detail and is available on request.

CHASSIS LINE

Minute Man Products, Inc., 430 E. 102nd Street, New York 29, New York, is currently offering its new line of standard chassis, relay rack panels, mounting brackets, and bottom plates through radio jobbers.

Featuring complete flexibility, stur-

diness, and availability, these metal products meet the requirements of amateurs, research organizations, and engineering departments.

Each chassis comes complete with a speedy template guide, a 16 x 22 inch simulated blueprint containing full scale drawings of holes most generally used in chassis and electronic circuits. This guide can be used as a reference or as an actual template aid.

SERVICE TOOL

W & M Sales and Engineering Co., 1211 N. Market Street, Wichita, Kansas, is in production on a unique tool which is especially well suited for radio and television servicing.

The tool consists of a lighted screwdriver with five slender, detachable blades designed particularly for radio and television applications. The whole unit is compact and small enough to permit its use in crowded chassis. The light, which is an integral part of the handle, provides sufficient light for working inside cabinets or on large chassis.

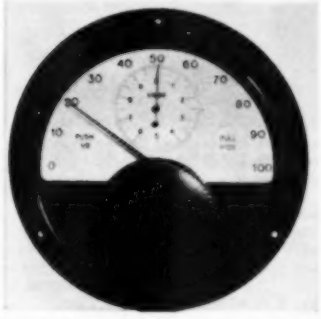
The product is being marketed by the company itself and additional details and prices are available on request.

TWO-SPEED DRIVES

Transradio Ltd., 138A, Cromwell Road, London S.W.7, England, is in production on a new two-speed precision drive unit which has been tradenamed the "Microdual."

This unit is designed to provide absolute accuracy in the control of angular movements for variable condensers, inductances, wavemeters, etc. The "Microdual" provides exact angular movements from 0 to 180 degrees without backlash from a single control knob. A coarse searching speed and fine setting control are available over the entire range.

A data sheet, D1, containing complete information on this new unit is available from the company on request.



CORNER HORN ENCLOSURE

Electro-Voice Inc., Buchanan, Michigan, has introduced a new *Klipsch*-licensed, moderately-priced folded corner horn enclosure designed to accommodate the company's 15" coaxial speakers and for 800 cps separate 2-way and 3-way speaker systems.

TV DIRECT FROM THIS GREAT FACTORY TO YOU

BRINGS YOU

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TRANSVISION Picture Tube PRICES

Type	Your Cost if no old tube is traded in—DEALER PRICE—	Allowance for old tube	Your FINAL COST, if old Tube is turned in, DEALER NET—
10BP4	$17.95	$2.50	$15.45
12JP4	17.95	2.50	15.45
12LP4	19.95	3.00	16.95
14BP4	19.95	3.00	16.95
16DP4	27.95	4.00	23.95
17BP4	25.95	4.00	21.95
19MP4	37.00	5.00	32.00
20CP4	35.95	5.00	30.95
24AP4	69.95	—	—

So IMPORTANT is this great instrument, that on Jan. 28 the N. Y. TIMES devoted a feature article (copy on request) to the TRANSVISION

TESTER-REACTIVATOR

FOR PICTURE TUBES

Tests Picture Tubes and Renews Brightness of Your Dim Picture Tubes. Without removing picture tube from set, *measure Cathode emission . . . locate shorts between elements . . . locate high resistance shorts or leakage as high as 3 megohms.* Then, REACTIVATE dim picture tubes if there's no mechanical break in tube. 110V-60 cycles; weighs 3 lbs.

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Fully Guaranteed.

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Improve TV installations; save half the work with the Transvision Field Strength Meter. Model FSM-1, complete with tubes.. $59 net

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Ideal for Custom-Building or Conversion. Factory prices start from $49. Send for Cabinet Catalog now.

MULTI-SET CONNECTORS

feed up to 3 TV Sets from 1 Antenna

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For 3 or 4 sets..... 7.95 list*

*Dealers, write for discounts

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NEW TELEVISION
Videometer

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TELEVISION PICTURE
ON ANY CHANNEL

The HICKOK Model 650 Videometer is the first instrument of its kind to accurately and rapidly solve your servicing problems with the necessary tests to visually identify trouble in any section of a TV receiver.

FEATURES:

- An all-purpose video generator. Provides an electronically accurate bar or dot pattern on the screen of any TV receiver —independent of station operation.
- Can be used as a TV transmitter to simultaneously transfer a picture to any number of TV receivers—on any desired channel.
- RF output, directly calibrated in microvolts for sensitivity measurements.
- Substitute Video Amplifier with gain of 0 to 10.
- Crystal controlled timer for greater accuracy.
- Fast, accurate, the ideal instrument for all area servicing.
- Increases TV maintenance profits—allows you to trouble shoot many more installations per day.
- Built only by HICKOK. Contains highest quality components throughout for lasting accuracy and dependability.

Write for the new, complete Hickok Test Instrument Catalog today.

THE HICKOK ELECTRICAL INSTRUMENT CO.
10524 Dupont Avenue • Cleveland 8, Ohio

Employing the walls of the room as an extension of the exponential air load on the driver, the unit is flat within ± 5 db down to 30 cps. An adaptable baffle board arrangement permits

mounting the 15" coaxial speaker or the 2- or 3-way systems without modification.

The new "Royal" enclosure measures 37" high, 20½" deep, and 22¾" wide. It weighs 69 pounds. The unit is currently available in either mahogany or blonde finish.

Bulletin 183 includes complete details on the new "Royal" unit and is available on request.

NULL INDICATOR

Marion Electrical Instrument Company of Manchester, New Hampshire, has recently introduced a new "ruggedized," hermetically-sealed null indicator which is currently available in two models.

Mounting requirements and physical dimensions of these new units conform to JAN-1-6 standards. Although center-point sensitivity is high (1 μa. per mm or higher), the meter's shaded pole face and shielded core construction are said to give sharply logarithmic attenuation as deflection departs from the null point, and to provide ample overload protection. Stated maximum safe current is ten times actual rated full scale value.

The Models HS2 (2½" size) and the HS3 (3½" size) are available in numerous current sensitivity styles and internal resistance characteristics.

50-WATT RHEOSTAT

Harduck, Hindle, Inc., Newark 5, New Jersey, is in production on a completely redesigned 50-watt rheostat, the H-50.

Features of this new unit include a toroidal ceramic form wound with resistance wire which is coated and bonded to a refractory base by means of the company's new high-temperature vitreous enamel. The unique design of the contact arm permits the use of a "bus bar" type brush which affords a minimum of resistance between the resistive element and collector ring. The self-adjusting feature provides positive smooth electrical control.

The terminals of the H-50 are made of strong, corrosion-resistant alloy. The units are designed to comply with current standards of JAN-R-22, RTMA, NEMA, and are listed by *Underwriters' Laboratories, Inc.*

A data sheet on the H-50 is now available on request.

SIGNAL GENERATORS

Decade Instrument Company of Caldwell, New Jersey, has introduced a new signal generator which incorporates several interesting features.

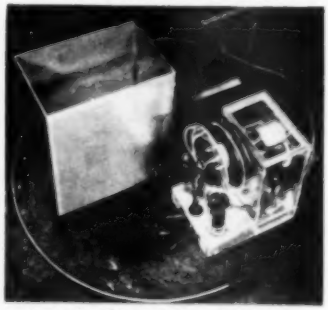
These new generators have been developed for the range from 10 kc. to 100 mc. Known as "Decalators," they consist of a series of decade-switching oscillators. The units feature direct readings for 9000 separate steps of frequency; high frequency accuracy without the use of charts or dial; frequency settings which are obtainable with simple decade-switching; excellent short term stability, plus or minus 2 cycles on all frequencies; high accuracy, plus or minus .05%, at maximum frequency.

The Model #10-100 with a frequency range of 10 kc. to 100 kc. is currently available and other models will be forthcoming shortly.

H.V. POWER SUPPLY

North American Philips Company, Inc., 750 S. Fulton Avenue, Mt. Vernon, New York, has introduced a new low-cost, regulated high-voltage d.c. power supply unit for use with cathode-ray and Geiger counter tubes.

This miniaturized unit is light in weight, operates at temperatures from minus 30 degrees C to 80 degrees C



and can be adapted for many applications, particularly airborne and radar equipment.

Input is 315 volts d.c. at 50 ma. Output is 18 kv. d.c. at 150 μa. maximum. Taps may be provided at lower voltages to supply intermediate accelerating anodes. The a.c. ripple averages 1%. The unit is built to withstand 21 kv. at 50% humidity.

Dimensions of the power supply unit are 6" wide, 5¼" high, and 3½" deep. It weighs 2½ pounds. Volume is approximately 110 cubic inches.

POWER OUTPUT METER

Daven Company, 191 Central Avenue, Newark, New Jersey, is currently offering a new, 50-watt output power meter, the Type OP-961, to the trade.

The new meter has been especially

(*Continued on page* 138)

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10% DISCOUNT on orders of 100 tubes or more, all brands.
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Double "V" TV Antenna Kit 300 ohm line, insulators, guy wire, hardware, full size antenna with double length 5 ft. mast **$7.95** Complete Kit

Quantity		Quantity		Quantity		Quantity		Quantity		Quantity	
	6Z4 59c		6AB7 $1.15		6J5GT $ .54		7A6		12BE6 $ .65		35B5 72c
	6Z4G		6AC5GT 1.31		6J6 1.04		7A7		12BF6 .89		35C5 .59
	1A5GT .65		6AC7		6J7G .79		7A8 81c		12BH7 1.08		35L6 .59
	1A7 .99		6AG5 1.19		6J8G 1.15		7B4		12C8 1.15		35W4 .45
	1B3GT .95		6AG7 1.44		6K5GT .87		7B5 .81		12F5GT		35Y4 99c
	1B5		6AH6 1.40		6K6GT .59		7B6 .81		12H6 65c		35Z3
	1C7G 29c		6AK5		6K7GT .79		7B7 .81		12J5GT .54		35Z4 54c
	1E7		6AK6 1.08		6K8GT .87		7B8 .81		12K7GT .79		35Z5
	1H6		6AL5 72c		6L5G .95		7C4 1.44		12Q7GT .65		35Z6G .95
	1H5GT .65		6AQ5		6L7 .87		7C5		12SA7GT .72		35 51 .79
	1H6G 1.35		6AQ6 .81		6M6G 1.40		7C6 81c		12SC7 .79		41
	1J5GT .95		6AR5 .74		6N7GT		7C7		12SF5GT		42 72c
	1L4 .29		6AT6 .54		6P5GT 1.08		7E6 .93		12SF7 72c		43
	1LA4		6AS5 .90		6Q7GT .65		7E7 1.19		12SH7GT .79		45
	1LA6 1.19		6AU5GT 1.45		6R7GT .95		7F7 .99		16S J7GT .81		45Z5 .59
	1LC5		6AU6 59c		6S4 .65		7F8 1.76		12SK7GT .72		46 1.04
	1LC6		6AV6		6S7GT 1.15		7G7 1.19		12SL7GT .87		47
	1LD5 .95		6B4G 1.44		6S8GT .95		7H7 .98		12SN7GT .99		50A5 1.21
	1LE3 1.19		6B5		6SA7GT .72		7J7		12SQ7 .54		50B5 72c
	1LH4 1.19		6B6G .79		6SC7		7K7 1.19		12SQ7GT		50C5
	1LN5 1.19		6B8GT 1.15		6SD7GT 99c		7L7		12SR7GT .79		50C6G 1.04
	1N5GT .72		6BA6 .65		6SF5 .59		7N7 99c		12Z3 .95		50L6 .59
	1P5GT		6BA7 .87		6SF5GT .65		7Q7		14A7		50X6 .79
	1Q5GT 95c		6BC5 .72		6SF7 .72		7R7		14AF7 99c		50Y6 .59
	1R5		6BC7 .79		6SH7GT .79		7S7 1.19		14B6		70L7 1.40
	1S5 72c		6BD5GT 1.15		6SJ7 81c		7V7		14B8		71A .87
	1T4		6BE6 .65		6SJ7GT		7W7		14C5 1.19		75
	1U4		6BF5 .59		6SK7GT .58		7X6 .99		14C7 1.08		77 1.10
	1U5 .65		6BF6 .59		6SL7GT .87		7X7 1.19		14F7 .99		78
	1X2A .95		6BG6G 1.73		6SN7GT .79		7Y4		14F8 1.44		80 .61
	2A3 1.15		6BH6 72c		6SQ7 .54		7Z4 81c		19BG6G 2.15		83 1.45
	2A5 .79		6BJ6		6SQ7GT .59		12A7 1.15		19T8 1.04		85 .79
	3LF4 1.19		6BN6 1.44		6SR7GT .65		12A8 .79		20 1.40		117L7
	3Q4 .79		6BQ6 .85		6SS7 .72		12AH7 1.45		24A .79		117N7 1.40
	3Q5GT 1.08		6BQ7 1.58		6T7G		12AT6 .54		25AC5GT 1.04		117P7
	3S4		6C4		6T8 1.15		12AT7 1.04		25BQ6GT 1.15		117Z3 .54
	3V4 72c		6C5GT 59c		6U5 1.10		12AU6 .72		25L6GT .89		117Z6 1.08
	5T4 1.40		6C6 .79		6U6GT		12AU7 .65		25W4GT .72		807 1.55
	5U4G .59		6C8G 1.15		6U7G 79c		12AV6 .54		35X5 1.04		815 6.95
	5V4G .87		6CB6 .72		6V6GT .59		12AV7 1.15		25Z6GT .79		1294
	5W4		6CD6G 1.69		6W4GT .65		12AW6 .95		32L7GT 1.15		1299 29c
	5W4GT 59c		6D6 .79		6X4 .84		12AX7 .87		35A5 .90		1619 .45
	5X4G .65		6D8G 1.15		6X5GT .68		12BA6 .65				1629 .29
	5Y3GT .45		6E5 .79		6Y6G .87		12BA7 .87				2050 2.00
	5Y4G .54		6F5GT		7A4 .90						2051 1.15
	5X4G		6F6GT 59c		7A5 .90						7193 .87
	5Z3 81c		6F8G 1.15								VT51
	6A3 1.15		6G6G .95								VT52 29c
	6A7 1.21		6H6 .59								
	6A8GT .99		6H6GT .65								

TUBE SPECIALS!

6AU6	ea. 59c	6SK7GT	ea. 58c
6V6GT	ea. 59c	6BQ6GT	ea. 85c
12AU7	ea. 65c	6CD6G	ea. $1.69

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12" Coaxial FM Speakers **$12.95** ea.
High fidelity with high pass filter attached. 20 watt; 40-17500 cps. response; 8 ohm VC.
Very best quality—NATIONAL BRANDS Individually Packed

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4"	1.36	10"	5.38
5"	1.59	12"	6.54
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117Z3, 1U5, 3V4, 1R5, 1T4, AC-DC Portable Kit. All for	$2.89
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Six month guarantee

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12LP4	$16.95	16JP4	$29.95
12LP4A	$16.95	16RP4	$23.95
14PB4	$22.95	16TP4	$23.95
7JP4	$15.95	17BP4A	$24.95
16AP4	$29.95	19AP4A	$39.95

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300 ohm twin lead 55 Web virgin polyethylene, in either clear or brown, the finest available.
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TV INLINE FOLDED DIPOLE ANTENNA
At this price we cannot mention manufacturer's name, complete with mast, Ind. boxed. $7.98 each
6 for $7.29 each.

TERMS: 20% DEPOSIT with order, balance C. O. D. $1.00 handling charge for orders less than $5.00. All shipments F. O. B. Chicago. Our parts and tubes are warranted to be 100% replacements for the prototypes in the listings above. Prices are subject to revision without notice. SATISFACTION GUARANTEED. Illinois residents add 2% sales tax. ORDER TODAY!

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A REMOTE-CONTROL For Your TV Set

By

IRVING GOTTLIEB, W6RDM

A remotely positioned "front end" that can be used for audio volume control, station selection, and contrast adjustment.

THE arm-chair control of a television receiver may be accomplished by means of the arrangement diagrammed in Fig. 1. The principle of operation involves the substitution of a remotely-situated "front end" for that of the receiver. Station selection, audio volume control, and contrast can be adjusted from the actual viewing position. The system is intended to be used with conventional type TV receiver circuits, but will work well with intercarrier type video sets.

The i.f. output energy from the remote tuner is fed to the television receiver by means of shielded coaxial cable and is coupled by dropping a three-turn loop over the first i.f. transformer (the front end output transformer or coil). The oscillator tube or the mixer tube of the TV receiver is removed. The audio volume control of the receiver is set to a position corresponding to slightly greater volume than will normally be desired and the remote unit is ready for an initial trial. A few words are in order regarding the audio volume control on the remote tuner, since this is the feature which distinguishes this system from others.

The sound i.f. energy is attenuated by means of a tunable series wave trap, connected in parallel with the remote front end output coil. This series *LC* circuit must have a high "*Q*," otherwise two adverse effects will be evident. First, if the "*Q*" is not great enough the range of control of the audio volume will be restricted. Second, distortion of the picture will result as the wave trap "bites" into the video i.f. spectrum. From the author's experience, it is fairly certain that practical considerations rule out the possibility that the "*Q*" will be excessive. Of course the ideal trap for this purpose would have a rectangular rejection curve. Actually, it will be found that any single layer coil with a geometric configuration similar to those commonly used for television i.f. coils will be suitable, providing it can be made to resonate with approximately 10 $\mu\mu$fd. capacity. If the resonating capacity is much higher than this, it will generally be found that the "*Q*" is too low. On the other hand, attempting to resonate with much less than 10 $\mu\mu$fd. makes the initial adjustment quite tricky and may result in a restricted range of control. The distributed capacitance of the coil may cause an undesired and stray capacitance resonance in the video i.f. band.

The series wave trap coil, L_5, resonates at 21.25 mc. with capacitance comparable to that associated with wiring and stray capacitance. Because of this, the author has not included specifications for the home-winding of this coil but suggests instead that the situation be handled as follows.

Since the *RCA* Model 630TS is one of the most popular TV sets and since replacement parts for this receiver are almost universally available, the author would like to suggest that the sound i.f. transformers used in the second sound i.f. stages of this receiver be used for L_5. These transformers are designated T_{113} and T_{118} on the *RCA* schematics but carry the common stock number of 201K1.

To install such a unit in the remote tuner, merely remove the primary and secondary condensers of the i.f. transformer, insert the primary in the circuit position designated L_5 and disregard the secondary.

This works out well because the permeable slug can be used to compensate for the effects of stray capacitances which might otherwise shift resonance outside the range of the variable condenser "volume control." This slug introduces no deleterious effects in the form of undesired shunt resonances as appeared to be the case when a home-made coil was used in conjunction with a slug.

Once the experimenter achieves success with the wave trap, the only other "gremlin" likely to interfere with smooth operation is the possibility of i.f. frequency resonances in the *LC* circuits consisting of the two pickup loops and the inherent capacitance of the coaxial cable. Trouble of this nature can be eliminated by shunting capacity across either or both pickup loops. The need for such capacitance and the value thereof will depend mainly on the type and length of coaxial cable used.

The contrast control provides only vernier action for receivers employing a.g.c. but has sufficient control for receivers lacking a.g.c. so that manual compensation of signal strength, and therefore picture contrast, is provided right at the remote tuner. This is a necessity for such receivers because in changing channels the picture quality is usually affected. This remote tuner accomplishes this by controlling the gain of the r.f. stage.

When used with intercarrier sets, the volume of the sound is controlled not by the series wave trap but by detuning the station selector in such a way that the sound i.f. system in the intercarrier receiver is deprived of signal energy. This can be accomplished without greatly affecting the video i.f. channel. If a non-continuous tuner is used, the vernier tuning element will perform this function.

The power supply incorporated in the remote tuner may be of any type capable of delivering about 50 ma. at 100 to 150 volts. An added refinement, involving the use of a VR tube to maintain the output voltage constant, is worth considering, especially in areas where line voltage fluctuates considerably.

All-in-all, this device is inexpensive to build, simple to install, and contributes much to the pleasure to be derived from TViewing. Give it a try—you'll enjoy the results.

—30—

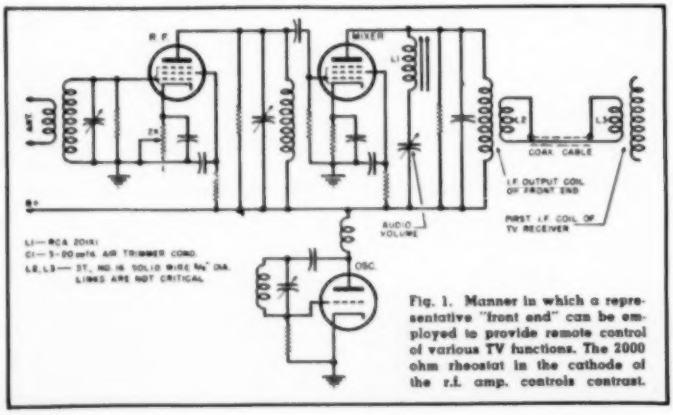

Fig. 1. Manner in which a representative "front end" can be employed to provide remote control of various TV functions. The 2000 ohm rheostat in the cathode of the r.f. amp. controls contrast.

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R·H·S

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Sigma Plate Relay 8000 ohm SPDT	2.49
RG58/U Coaxial Cable—75 ohm	
150' roll $11.95. 300' roll	$22.50
3" Square Shield	1.49
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15 MY @ 800 MA Choke	4.95
2 mfd 3000 V Condenser	4.95

TUBES!! BRAND NEW! STANDARD BRANDS! NO SECONDS! COMPARE! TUBES!!

0A2/VR75	$1.25	3C23	$10.95	215A	$0.95	811	$2.95	8005	$1.95	0A2	$1.25	5Z3	$0.85	6SK7GT	$0.75	12SJ7GT	$0.85
0B2/VR90	1.19	3C24 24G	1.75	217C	6.49	812	2.75	8011	1.59	0A4G	1.15	5Y3	.65	6SL7GT	.75	12SK7GT	.85
0C2/VR105	1.19	3D21/A/5C27	2.95	218	3.49	813	3.95	8012	2.49	0B2	1.49	5Y3GT	.65	6SN7GT	.75	12SL7GT	.85
0D3/VR150	.98	3C31 C1B	2.79	249B	3.49	814	2.00	8013	3.49	0C4		5Y4G	.65	6SQ7GT	.75	12SN7GT	.75
1B22	2.39	3C45	15.95	250B	5.49	815	2.00	8014	39.75	0A4A	.65	5Z4	.65	6SR7GT	.65	12SQ7GT	.75
1B23	2.39	3C45	15.95	250TH	21.95	816	2.00	8020	.95	0A5	.65	6A3	.85	6ST7	.85	12SR7	.75
1B24	0.75	3CP1S1	1.00	250TL	16.95	826	.95	8025	1.95	1A4P	.75	6AB7	.95	6ST7GT	.85	12Z3	.75
1B26	2.39	3D6	2.95	274A	5.95	828	6.95	8026	1.95	1A5GT	.75	6AC7	.95	6ST7GTGT	.75	12Z5	.75
1B27	18.95	3DP1A	4.95	274B	1.75	829	10.95	9002	1.95	1A6	.65	6AC7GT	1.00	6SV7	.85	14A7	.85
1B31	2.49	3DP1-X2A	8.95	304B	9.75	829B	12.95	9003	1.95	1A7GT	.85	6AD7GT	1.25	6SY7	.85	14B6	.85
1B32	3.75	3D21A	1.49	203A	2.00	850B	5.95	9004	1.95	1AB5	.65	6AD7GT	1.25	6T8	1.00	14B8	.85
1B35	18.95	3E29	13.95	304A	2.00	851	39.95	9005	1.95	1B3/8016	1.19	6AE6G	.75	6U5G	.65	14F8	.85
1B36	38.75	3E50	0.95	432A	9.95	852A	9.95	9006	1.95	1B4P	.85	6AF4	.85	6U6GT	.85	14H7	.85
1B42	4.75	3GP1	4.39	304TH	9.95	853A	45.00	C1A	1.95	1B5/25S	.65	6AG5	.65	6U7G	.65	14J7	.85
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1N21A "	1.95	4-65A	19.95	305A	34.95	857	2.00	C6J	.95	1C5GT	.75	6AH6	1.29	6V6GT	.65	14Q7	.75
1N21B "	1.95	4-125A	35.00	307A RK75	4.95	858	2.00	C8	.95	1C6	.65	6AK5	1.29	6W4	.65	14R7	.75
1N22 "	1.19	4-250A	35.00	310A	7.00	861	23.95	C10DD	1.95	1C7G	.65	6AK5	1.29	6W7G	.65	19BG6G	1.49
1N23 "	1.49	4AP10	4.95	311A	2.00	862	23.95	C15AX	1.95	1D5GP	.65	6AL5	.65	6X4	.65	25L6GT	.85
1N23A "	3.00	4B24 EL5B	10.95	325A/B	33.95	865	4.95	CK503AX	1.95	1D7G	.65	6AL5GT	.75	6X5GT	.65	25Y5	.85
1N23B "	6.95	4B24 EL5C	7.95	327A/5C27	4.75	869	37.95	CK505AX	1.95	1D8GT	.85	6AQ5	.65	6Y6G	.65	25Z6GT	.85
1N25 "	1.49	4B25	9.95	328A	5.95	872A	2.00	CK506AX	1.95	1E5GT	.85	6AT6	.75	6Z4	.65	35	.85
1N27 "	1.99	4B26 2000	4.95	331A	11.95	872	37.95	CK507AX	1.95	1E7G	.65	6AB5	1.25	6ZY5G	.65	35Z5GT	.85
1N34A "	.97	4B27	4.95	350B	2.95	873	2.00	CK508AX	1.95	1F5G	.65	6AU5	1.19	6AT4/SX1	.75	35W4	.65
1P21	45.00	4B32	4.95	350B	2.95	861	23.95	CK515AX	1.95	1F6G	.65	6AU6	1.19	7A5	.75	35Y4	.65
1P22	1.79	4B32 CV9212	4.95	368AS	1.95	865	.98	CK1006	1.95	1F7G	.65	6AV6	.75	7A6	.75	35Z3	.65
1P24	1.79	4C35	32.50	371A	4.95	865A	1.39	CK1009	1.95	1G6GT	.85	6AV6	.75	7A7	.75	35Z4GT	.75
1P26	2.49	4E27 257B	18.95	371B	4.95	866A	1.39	1F4G	1.95	1H4G	.75	6B4G	1.49	7A8	.75	36	.85
1P27	5.95	4E27	9.95	388A	1.95	866JR	1.39	EF183	1.95	1H5GT	.75	6B7	1.00	7B4	.75	37	.85
2AP1	10.95	5AP4	3.45	393A	7.00	866B	39.95	F123A	7.95	1H6GT	.75	6B8G	.75	7B6	.75	38	.85
2C22 RK33	.89	5AP4	3.45	394A	2.00	872A	3.95	F124A	27.50	1J6	.65	6B8G	.85	7B7	.75	38	.85
2C22/T193	.89	5BP4	4.45	417A	19.95	874	1.19	F128A	99.50	1L4	.65	6BC5	.75	7B8	.75	38A5	.85
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2J32	37.50	6C21	32.95	707B	19.95	959	3.95	KC4	32.95	1T5GT	.65	6H6	.65	7X7	.75	45	1.39
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2J34	37.50	6P7	3.95	715A	4.95	1603	4.95	KU611	4.95	1V	.65	6J5	.75	7Z4	.65	50A5	.85
2J36	110.00	7DP4	14.95	710A 8011	2.95	1613	.49	RK12A	1.98	1X2	.95	6J5GT	.65	12A	.65	50B5	.75
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2J38	11.95	7QP7	13.75	724A	4.95	1616	.49	RK59	1.98	2A5	.65	6J7	.65	12A7	.65	50L6GT	.85
2J39	37.50	7QP7	14.95	715A	4.95	1619	1.64	RK60	1.98	2A5G	.65	6J7G	.65	12AG7	.65	50Y6	.75
2J40	39.50	9LP7	9.95	715B	9.95	1622	.49	RK65	39.50	2A5	.65	6J7GT	.65	12AH7GT	1.19	51	.85
2J47	24.50	100P4	17.49	715C	29.95	1624	.49	RK72	1.98	2A6	.65	6K6GT	.75	12AL5	.65	56	.85
2J48	24.50	100P4	17.49	717A	4.95	1625	.49	RK73	1.98	2B7	.75	6K7	.75	12AT6	.65	57	.85
2J49	24.50	12DP7	14.75	721A	3.49	1626	.39	RX21A	1.98	2B7	.65	6K8	.75	12AU6	.65	58	.85
2J51	39.50	12DP7	14.75	723A	5.95	1629	.39	RX42	1.98	2V3G	1.00	6L6G	.75	12AU7	.65	70L7GT	1.35
2J54B	32.50	12HP7	14.75	725A	5.95	1630	.79	TE40	4.95	2X2	.95	6L6	2.25	12AV6	.65	71A	.85
2J55	39.50	12LP4	30.95	723A H	19.95	1631	.79	VR78	.95	2X2A	1.98	6L6G	1.00	12AU7	.65	70L7GT	1.35
2J61	49.50	12LP4	1.10	724B	3.25	1632	.79	VR91	.95	3A4	.65	6L6GA	1.00	12AV6	.65	71A	.85
2J62	49.50	15R	.99	725A	5.95	1633	.69	VR92	.95	3A5	.65	6L7	.85	12BA6	.65	75	.85
2K25	28.75	15R	5.49	726A	9.95	1634	.69	VT127A	13.95	3B7/1291	.65	6L7G	.65	12BE6	.65	76	.85
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2K29	21.75	28D7	2.29	730A	29.90	1638	.65	VU39	2.49	3LF4	.85	6Q7GT	.85	12F5GT	.65	78	.75
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3B24	6.25	75TL	6.25	803	3.75	1665	1.39	WL530	12.75	5R4GY	1.95	6SC7	.95	12SA	.72	84/6Z4	.75
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3B25	4.39	100TH	7.95	805	3.75	1960	4.95	WL532	9.95	5U4G	.65	6SF5	.75	12SA7GT	.75	89	.85
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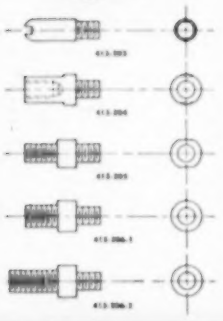

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Z-Matched Yagis

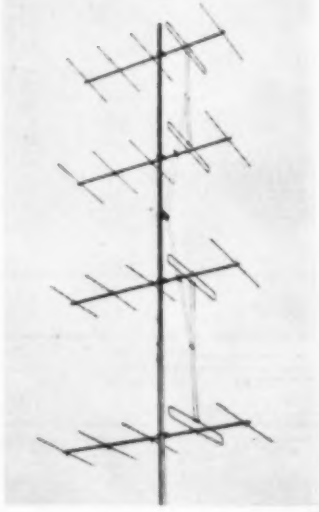
(*Continued from page 57*)

a universal clamp at any point of the tower. The cross booms are held in a section of tubing of larger diameter so that the first yagi of each pair can be put on, the connecting rods attached, and then swung into the upper position by rotating the boom. Then the lower yagi is put on. The identical process is repeated for the other pair of yagis. Before discussing the electrical considerations in phasing and matching four yagis, it is interesting to note that the "Supermount" can be used for mounting stacked yagis of two different channels even though they require separate orientation.

In the article, "The Yagi Antenna" published in RADIO & TELEVISION NEWS, October 1951, the problem of matching a two-bay yagi to 300 ohm line was discussed. A system, subsequently named the "Z-Match" system, was described. In this system, the single yagi uses a three-conductor fold and by wider spaced elements is designed to accurately match 300 ohm line. The impedance is dropped to 200 ohms by taking out the center bar in the folded dipole. The center bars from the two yagis are then used as the linear matching transformers and they step the 200 ohm impedance up to 600 ohms. The two 600 ohm impedances in parallel total 300 ohms and match the line accurately. It is two arrays of this description which are to be stacked in four bays. From the following, it will be evident that an accurate two-bay impedance of 300 ohms is necessary.

In the case of the high-band yagis, the four arrays were stacked vertically

Fig. 3. The "Supermount" antenna stacked vertically. Because the unit is adjustable, several arrangements are possible.



with half-wave spacing between each bay (Fig. 3). On the low band, the two half-wave stacked arrays were spaced a full wave apart. Since these dimensions made the use of a quarter-wave transformer impossible, and since half wavelengths of line do not transform impedances, two ¾ wavelengths of line were used. This length has the same impedance transforming properties as a quarter-wave line. That is, the matching impedance is equal to the square root of the input impedance multiplied by the output impedance or $Z_m = \sqrt{Z_1 \times Z_2}$. Therefore, the problem resolved itself into the following considerations. We knew that in order for the feed point of the entire four-bay array to match 300 ohm line, each two-bay antenna had to present an impedance of 600 ohms. These two 600 ohm impedances in parallel equalled 300 ohms which was the required impedance. We also knew that each two bay "Z-Match" array had an impedance of 300 ohms. The problem then was to transform the 300 impedance of each two-bay yagi to 600 ohms through the ¾ wave transformer. Substituting in the formula $Z_m = \sqrt{Z_1 \times Z_2}$ we get the following: $Z_m = \sqrt{300 \times 600}$ or $Z_m = 425$ ohms. In other words, a ¾ wave line having a characteristic impedance of 425 ohms will tie the two stacked yagis into one four-bay array with all impedances matched to 300 ohms.

The entire system is shown schematically (Fig. 2). Electrically, the system is the same whether the stacking is vertical or horizontal. Special 425 ohm harnesses were developed for each band. On the high band, a self-supporting open-wire system was used. On the low band, a special wide-spaced 425 ohm ribbon type transmission line was developed because ordinary open-wire line was difficult to support on the boom structure.

-30-

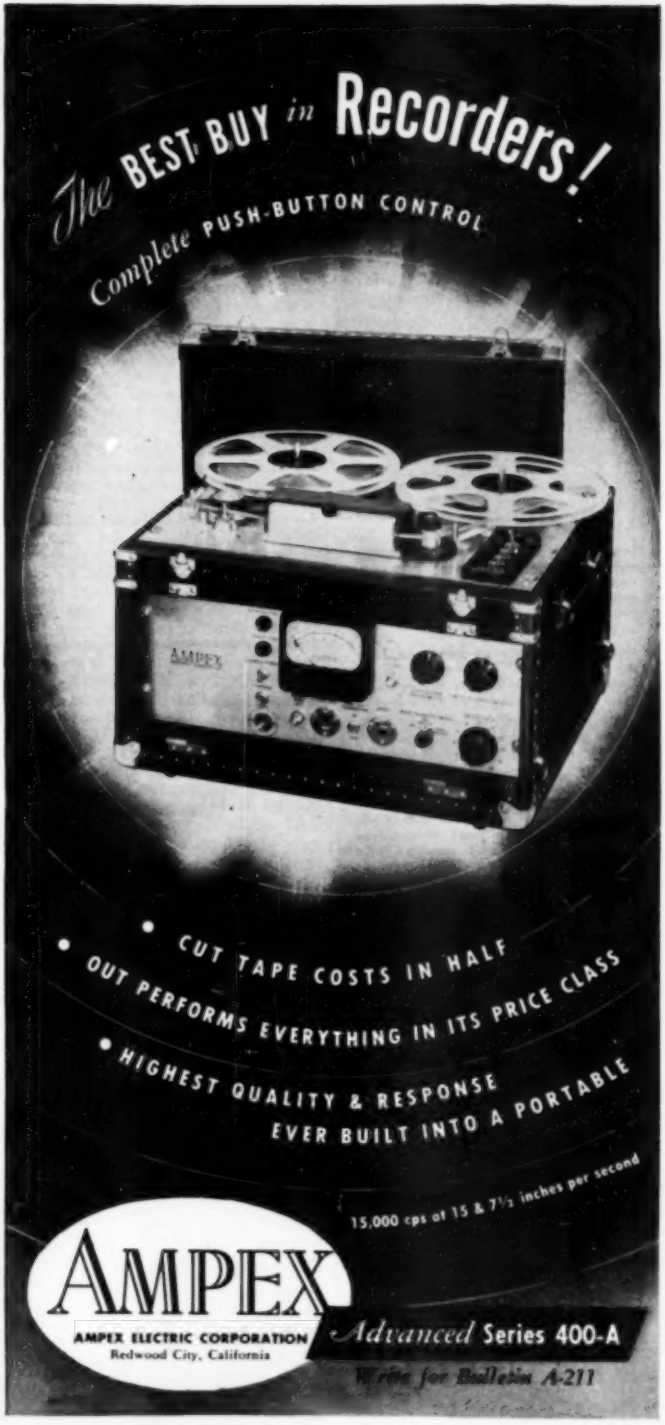
NEW MICROWAVE CHANNELS

THE Long Lines Department of American Telephone and Telegraph Company has filed application with the FCC for authority to provide additional channels for television service between Chicago, Omaha, and San Francisco. The additional channels will operate over the transcontinental microwave radio-relay system that now carries both telephone and television circuits.

At present there are two channels for television, one in each direction, between Chicago and San Francisco and an additional westbound channel in the Chicago-Omaha section.

Of the three new channels, one will be placed in service late this year and will operate from Chicago to San Francisco. The other two channels will be placed in service in 1953, adding one channel from San Francisco to Chicago and one from Omaha to San Francisco. Upon completion of this project there will be five channels available for full-time TV service, three westbound and two eastbound.

The network now has 24,000 miles of channels, 14,000 miles carried by radio-relay, the balance by coaxial cable.-30-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Mobile V.F.O.

(*Continued from page 53*)

cabinet. A hole must be made in the cabinet, on the top or bottom, so that the bandset condenser C_3 can be adjusted by means of a screwdriver or alignment tool.

The main tuning condenser C_1 should first be set to the high frequency end, or minimum capacity, and the padder C_2 then adjusted to a value which results in oscillation at a frequency of about 4.05 megacycles. Setting the tuning condenser C_1 to maximum capacity will then change the frequency to approximately 3.75 megacycles if the values of L and C shown in the schematic are used. This gives a bandspread of over three quarters of the dial to the 75 meter phone band from 3.85 to 4.0 megacycles.

With the v.f.o. connected to the stage to be driven in the transmitter, and the tuning condenser C_1 set at 3.9 megacycles, the slug in L_3 should be adjusted for maximum grid current in the final, or the stage being driven. The tank circuit in the transmitter, to which the link is coupled, should also be tuned for maximum grid current in the driven stage. A definite peak will be found indicating that the circuits are tuned to resonance. If this value of grid current, at the peak, is greater or less than the rated grid current of the tube, the link coupling to the stage can be increased or decreased accordingly. If a different coil form or a slug of different permeability is used for L_3, it may be necessary to change the value of C_{13} or the number of turns on the coil in order to reach resonance. A grid dip oscillator will again find use here in determining the resonant frequency of the L_3-C_{13} combination.

The v.f.o. drives the final directly in this installation as can be seen from Fig. 2. The final is a 6BQ6 and it is driven to 3.5 milliamperes of grid current over nine feet of coax. The unit has also been used successfully to drive 2E26 and 807 finals to rated grid current.

It is to be understood, of course, that the characteristics of the final, the antenna coupling circuits, and the type of antenna used will all determine the amount that the transmitter frequency can be changed without the necessity of retuning the final. In our case it was not possible to QSY the entire 150 kilocycles of the 75 meter band without retuning due to the rather sharp tuning characteristics of the antenna in use. However, the range available without serious loss of signal strength at the receiving end is great enough to warrant the use of the v.f.o. rather than crystal control. The ideal arrangement would, of course, be an installation in which the entire transmitter is located on the front panel of the automobile. Retuning could then be accomplished from the driver's seat in case it was necessary after changing frequency.

Tests with several stations, while in motion, brought forth no reports of frequency instability even while driving over streetcar tracks and rough roads. All-in-all, the v.f.o. has proven to be a worthwhile addition to the mobile rig.

–30–

FREE HAM TRAINING

THE Delco Radio Club of Delaware County, Pa. has approved a plan for sponsoring a beginner's class to teach code, theory, and practical application of radio knowledge. Emphasis will be placed on license requirements.

The club has made available its club house at Front Street and Providence Road in Media, Pa. for these training sessions and will provide the necessary materials for carrying out the program. There is no charge of any kind for this training.

Classes will meet each Tuesday evening at 8 p.m. and complete details on the program are available from the club's secretary, Ralph R. Garrick, 2525 Olcott Ave., Ardmore, Pa. Ardmore 4987-W. –30–

Andrew L. Lawson, JA2CL, who operates the oldest amateur radio station in Japan, is one of the most popular civilians at FEAMCOM. His popularity stems from his hobby of reuniting servicemen with their families in the States through ham contacts. Pic. Samuel R. Estabrooks (right) talks to his family in Hawaii as Mr. Lawson supervises.

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Crispening and Resolution Improvement in TV Receivers

By EDWARD M. NOLL

For both monochrome and color, "crispening" will help to accentuate small area contrast.

"CRISPENING" is a term used to identify the new *CBS* technique for improving the apparent resolution in a TV picture. However, in these days of intercarrier i.f. systems, network transmission, large picture tubes, and limited resolution, crispening has its application in monochrome receivers as well as in the color field. Crispening, by accentuating small area contrast, helps to recapture some of the brightness definition that is lost by the poor high frequency response of the television receiver.

Where the highs are deficient, the sharp transitions in brightness cannot be followed with fidelity. As the scanning beam at the camera tube scans a (assumed) black bar (See Fig. 1) in a televised scene, there is a sharp transition from white to black and a similarly abrupt return to white as the bar is passed. The resulting signal formed for each line as the beam scans the bar from left to right is similar to the squared pulse of waveform A in Fig. 1.

During the transfer of this signal from the camera tube to the picture tube a degeneration of highs causes an integration of the pulse, resulting in a waveform of the type shown in Fig. 1B. This type of signal, when applied to the grid of a picture tube, causes a gradual change from white to black at the edge of the bar and a slow smear-like transition back to white at the end of the bar. Because of this the edges of the bar do not stand out clear and crisp in the picture.

It is the function of a crispening cir-

Fig. 1. Waveform improvement by "crispening." (A) Pulse representation of single line of video. (B) Result of poor high frequency response. (C) Crispening spikes. (D) Effective resultant with crispening.

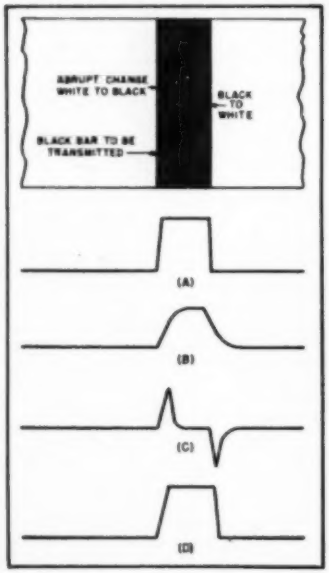
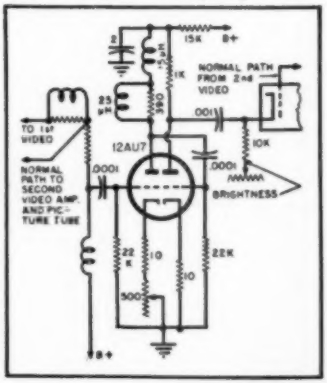


Fig. 2. Schematic of "crispening" circuit.



cuit to recover some of the original sharp change in brightness at the leading and trailing edges of the bar. A crispening circuit can be added to the video amplifier of practically any receiver, as shown in Fig. 2. In this system, the normal video signal path from the video detector to the grid of the picture tube is not interrupted. Instead an alternate path is provided through the crispening circuit to the cathode of the picture tube.

A crispening circuit of the type shown consists of a two-stage differentiation-amplification system which is made up of short time-constant *RC* coupling circuits and peaking coils. The differentiators emphasize the high frequency portions of the video signal which are present in all fast transitions of brightness. They really form spikes that follow edge changes of the original information more faithfully than the video signal passing over the normal video amplifier path. Spike high frequency changes are shown in the waveform of Fig. 1C.

The normal video signal is applied to the grid of the picture tube while the spikes formed by the crispening system are applied to the cathode of the picture tube. These spikes are of such a polarity as to reinforce the original slowed-down changes present in the video signal applied to the grid. The combined influence of these two separate signals is similar to the waveform of Fig. 1D which shows how the leading and trailing edges follow the original changes more closely than the signal of the waveform shown in Fig. 1B.

This basic circuit can be installed in monochrome receivers having a limited frequency response. In installing such a system it is important to remove excitation for the crispening circuit at a point which will provide spikes of a proper polarity to reinforce the changes being applied to the grid of the picture tube, *i.e.*, the cathode and grid signals must be of opposite polarity. A control in the cathode circuit permits spike amplitude regulation and is adjusted for best picture appearance without overshoot (intense white following the black). If the gain is not adequate, as could be the case when a single-stage video amplifier is used in the receiver, an additional crispening stage can be used or experimental increases made in the value of the plate load resistor.

There are more elaborate versions of crispening systems that have higher ratios of resolution improvement. In fact, apparent resolution of specific types of information (sharp transitions that are a part of the extended information in televised scenes) can be more than double the high frequency limit of the bandwidth. It certainly provides a convenient means of improving small area contrast. It is of particular benefit in a field sequential color television system that must sacrifice response in favor of a higher field rate.

—30—

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Audio Simplified

(*Continued from page 76*)

are not yet completely understood. The loudspeaker particularly, of all the components of the sound reproducing system, should be chosen by a listening test because the ear is the best judge of the over-all integration of the many complex factors which are involved in loudspeaker design.

The actual details of the loudspeaker design and construction are not of as much interest to the audio experimenter as the actual performance of the various designs. The basic loudspeaker is the simple cone loudspeaker in which the paper cone is caused to vibrate by the current in a small coil mounted between the poles of a magnet. The construction of this type of loudspeaker is shown in Fig. 6. Other types of loudspeakers are essentially variations of this basic design.

The single-cone loudspeaker can be used alone for good sound reproduction, but in many cases variations of the single-cone loudspeaker are used to give better reproduction. A simple and effective method of obtaining a wide frequency range is to use two loudspeakers — a large-cone speaker with good low-frequency and poor high-frequency response for reproduction of the lows, and a small-cone speaker with good high-frequency and poor low-frequency response for reproduction of the highs. Most of the best loudspeaker systems use this method in one form or another to obtain good frequency response. Two types of dual loudspeakers are illustrated in Fig. 7. The type illustrated in A consists of two separate speakers which may be mounted separately with the high-frequency unit (sometimes called the "tweeter") physically separated from the low-frequency unit (which is some-

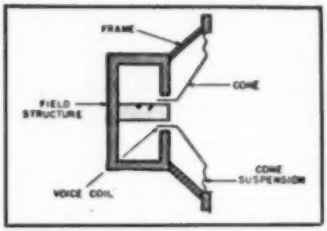

Fig. 6. Construction of a dynamic speaker.

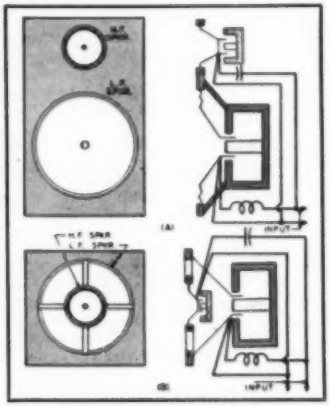

Fig. 7. Use of separate high- and low-frequency speakers to obtain wide frequency range. (A) Two separate speakers mounted separately. (B) Coaxial structure with the high-frequency unit mounted in the center of the low-frequency loudspeaker.

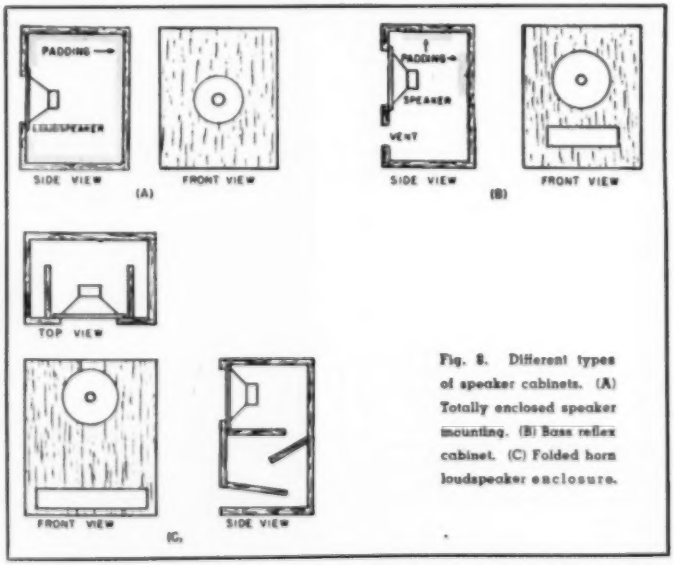

Fig. 8. Different types of speaker cabinets. (A) Totally enclosed speaker mounting. (B) Bass reflex cabinet. (C) Folded horn loudspeaker enclosure.

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Type	Input Volts	Input Amps	Output Volts	Output Amps	Radio Set
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DM416	14	6.2	330	.170	RU 19
DM33A	28	7	540	.250	BC 456
PE101C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1.75	285	.075	APN-1
ZA0515	12/24	4/2	500	.050	
B-19 pack	12	9.4	275	.110	MARK II
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	5	
5053	28	1.4	250	.060	APN-1
PE73CM	28	19	1000	.350	BC 375
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
PE94	28	10	300	.200	SCR 522
			150	.101	
			14.5	5	

INVERTERS

PE-218-E: Input: 25/28 vdc, 92 amp. Output: 115 v. 350-500 cy 1500 volt-amperes. Dim. 17"x6½"x10". New **$34.50**
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PE-206: Input: 28 vdc, 38 amps. Output: 80 v 800-cy. 500 volt-amps. Dim. 13"x6½"x10½". New **$22.50**
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Motors, 3 RPM—115V, 60 Cy **$ 1.65**
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ART-13 Driver Trans. 6V6 to P-P 811's **1.39**
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Sens. Relay: 3.5MA, 13K ohms, 2PST, 2A **1.29**
Klixon Breaker: Thermal, 35A **.69**
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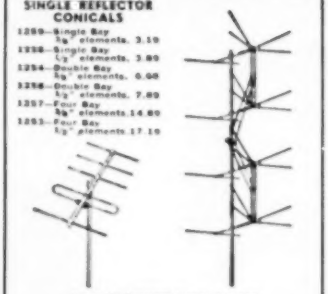

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times called the "woofer"), or B the two speakers may be mounted in a single coaxial structure with the tweeter at the center of the woofer. When two loudspeakers are used in this manner, the frequency below which the low-frequency speaker receives the electrical signal and above which the high-frequency speaker receives the signal is called the "crossover frequency." The "crossover network" for separating these frequencies which in the simplest case consists merely of a capacity in series with the tweeter and an inductance in series with the woofer, permits signals of the correct frequency to energize the proper loudspeaker.

The other commonly used method of obtaining good loudspeaker frequency response is by use of the "duocone" principle in a single loudspeaker. A double cone is used, so that whereas the entire cone moves at low frequencies, at high frequencies only the center section moves. This type of loudspeaker gives the same type of performance as the dual coaxial unit, but has a much simpler construction and all the sound originates in the one loudspeaker. Extremely good results have been obtained with the use of loudspeakers of this type.

Loudspeaker Baffles

Loudspeakers are designed for a wide frequency response, with a large cone for good low-frequency reproduction and a small cone for good high-frequency reproduction. However, the size of the loudspeaker cone alone will not insure adequate low-frequency reproduction, and for good performance, the loudspeaker must be mounted in a proper type of cabinet.

If the loudspeaker is mounted alone in free air, the sound from the back of the cone is 180° out-of-phase with the sound from the front. At low frequencies where the wavelength of the sound is much greater than the dimensions of the loudspeaker, the sounds from the two sides of the cone tend to cancel each other. To reduce this effect, it is necessary to mount the loudspeaker in a *baffle* which prevents this interference. Many different types of baffles have been developed to give better low-frequency reproduction from a loudspeaker, at the same time being reasonably economical and not requiring an excessive amount of space.

The simplest type of baffle is obtained by mounting the loudspeaker in a very large plane surface or wall, so that the sound from the back has to travel a great distance to reach the front, and cancellation will take place only at very low frequencies which are normally not heard. For good reproduction of frequencies down to 50 cps, the baffle should be approximately 8 feet square, with the loudspeaker mounted off the center. When loudspeaker response curves are given by the manufacturer, they are generally measured in a large baffle of this type. This method of loudspeaker baffling is quite popular for built-in home reproduction systems, where the speakers

are often mounted in a wall or a closet. It has, however, the disadvantage that it requires a considerable amount of space or a convenient wall.

The most common type of mounting for loudspeakers in commercial radio receivers and sound reproducers is the conventional open-back cabinet which also contains the receiver-amplifier chassis and the phonograph mechanism. This baffle is objectionable acoustically, because the enclosure behind the loudspeaker acts as an open-ended resonant tube and accentuates the response at its resonant frequency. This resonance generally occurs somewhere in the frequency range between 100 and 200 cps, and results in the "boomy" quality which is so characteristic of most commercial radio receivers. These faults are not present in properly designed cabinets. Good results are obtained by mounting the loudspeaker either in a back-enclosed cabinet, in a bass-reflex cabinet, or in a folded-horn cabinet.

The back-enclosed cabinet is a simple baffle consisting of a rigid box which completely encloses the back of the speaker, and padded on the inside with sound absorbent material. Thus the sound from the back of the cone is completely absorbed. The effect of the cabinet volume coupled to the speaker is to raise its resonant frequency, therefore the volume should be as large as is conveniently possible, and this type of cabinet is most suitable for loudspeakers whose resonant frequency is quite low.

At low frequencies, the coupling between the loudspeaker and the air depends upon the size of the cone. If the cone is made large enough for effective low-frequency response the high-frequency response is reduced, and considerable expense is involved in purchasing the large low-frequency unit and an additional high-frequency unit. The bass-reflex cabinet is a simple and effective method of increasing the coupling to the air by acting as an acoustic phase inverter, and adds the sound from the back of the cone in-phase with the sound from the front at low frequencies. It consists of a closed cabinet with an opening through which the volume is coupled to the air and has the same effect as a resonant *LC* circuit. Best results are obtained when this resonant frequency is the same as that of the loudspeaker, and when the area of the opening is approximately that of the cone. The bass-reflex cabinet is widely used in high-quality sound reproducing systems, and has given excellent results with speakers ranging in size from 8-inch to the large 18-inch woofers used in theaters and auditoriums.

The folded-horn type of cabinet has become widely used in home reproducing systems where the best low-frequency reproduction is desired. In this type of cabinet the sound is radiated from the front of the speaker cone at high frequencies, and through a horn coupled to the back of the cone at low frequencies. When the cabinet is

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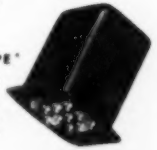

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(Concluded next month)

International Short-Wave

(Continued from page 69)

Radio Algerie now on 6.200 at 1600-1800. However, a recent *WRH Bulletin* said *Radio Algerie* can now be heard at 1500-1800 over 6.145 and 7.280.

Andorra — Radio Andorra, 5.990V, noted with sponsored programs around 1515; much QRM; identifies in French and Spanish. (Mudryj, Mich., via United 49'ers Radio Society)

Anglo-Egyptian Sudan—Radio Omdurman, is using 9.746, 5.975 (at 2315-2345 only) and 17.900; schedule is Arabic 2315-2345, 1130-1430; on Fridays has additional programs in Arabic 0300-0430, 0900-1000; *English* is Fridays 1230-1300; the 16-m. outlet is still experimental. (*WRH Bulletin*)

Angola—CR6RP, Radio Clube do Cuanza Sul, Redondo, gives its frequency as 7.895 and output as 250 watts; schedule of 0700-0845, 1330-1545. (Radio Sweden) Luanda, 11.862, noted at fair level 1300-1530 with varied musical program. (Sutton, Ohio) In verifying the 11.862 outlet for Bellington, N. Y., station officials also listed 9.632. Bellington recently noted the 11.862 channel on extended schedule to 1731 sign-off.

Radio Diamang, Dundo, CR6RG, is noted on a *new* channel of 6.86; high level at 1300-1430; gong note precedes call; woman announcer; closes 1430 with "A Portuguesa." (Ridgeway, South Africa)

Argentina — LRU, 15.29, Buenos Aires, noted with *English* 2330-0100, fair level. (Balbi, Calif.) Starts *English* on this channel for North America 2300. LRA, 15.345, is noted signing off 0100, good level some nights, according to Saylor, Va. The *new* 15.345 outlet is used primarily for Spanish-language sessions.

LRA, 17.720, noted 1945 in *English*. (Niblack, Ind.) This one is used for *English* to North America 1730-2030.

LRT, 11.842, Tucuman, *Radio Independencia*, noted 1830 with good signal. (Catch, England)

Austria — Blue Danube Network, 9.617, noted 1000 with news headlines; noted another day with news 0600. (Pearce, England) This one heard on 5.080 at good strength around 1500. (O'Sullivan, England)

Brazil—Radio Record, 15.135, noted signing on 0300 with foreign-language session. (Saylor, Va.) *Radio Nacional*, 9.720, heard 2030 with call. (Sams, Oregon) This one noted to 2210 sign-off at fair level. (Oestreich, Washington State) Also heard by Eccles, Minn.

ZYB5, 4.935, *Radio Poti*, Natal, noted 1620 with gongs and call by woman announcer; ZYP23, 5.045, Petropolis, heard with short newscast in Portuguese 1817. (Catch, England)

British Guiana — ZFY, 5.980A, Georgetown, signs on 0445; relays BBC news 0600. (Nichols, W. Va.)

British New Guinea—VLT9, 9.52, Pt. Moresby, noted 0215 to 0300 sign-off; fine signal with a little trace of CWQRM. (Langerdorf, Nevada)

British Somaliland—Radio Somali, 7.125A, noted to 0930 closedown. (Radio Sweden)

Bulgaria—Radio Sofia, 7.671, excellent level 0055 in native. (Kary, Pa.) *English* periods are 1500-1514 and 1600-1629 on 6.070; 2000-2020, 2300-2314 on 9.700A. (Radio Sweden)

Burma—The *English* programs from Burmese Broadcasting Service, Rangoon, can be heard 2015-2030 (*not* Sun.) on 9.543; 0115-0145 (*not* Mon.) on 6.035, 9.543; and 0915-1015 daily on 4.775, 9.543. (*WRH Bulletin*)

Canada—CBNX, 5.970A, St. John's, Newfoundland, noted 1430 with weak level in New York. (Mast)

VE9AI, 9.540, Edmonton, Alberta, has news 1430; usually is good level in Washington State during daylight; announces as CJCA (m.w. outlet on 930 kc.). (Tarr) Heard at good level 1005-1014. (Locke, La.) Noted 1730-1830 at high level. (Oestreich, Washington State)

Canary Islands — EA8AB, 7.518A, noted 1650 with operatic music; at 1700 clock chimes "10 p.m."; follows with music; closes 1800 after news in Spanish. Ends with "Viva Franco! Arriba Espana!" and Spanish march. (Pearce, England)

Cape Verde Islands—Praia, 5.860A, gives news of Portugal in Portuguese at 1630, signs off 1700 with "A Portuguesa." (Kary, Pa.)

Ceylon—Radio Ceylon, 15.120, opens 2045 with request session; noted still at good volume 2245; heard on 17.730 with sponsored musical program 0015. (Sanderson, Australia) Heard signing off 1145 on 11.975 but one day ran to 1215. (Fuller, Rhode Island)

Chile—CE622, 6.221, Santiago, noted 2245-2335 sign-off. (Machwart, Mich.)

China—Latest schedules from *Radio Peking* list Japanese 0600-0630 on 11.690, 15.060, 9.020. Sends QSL card now. (Pearce, England) The 15.056A channel noted in Chinese 2240. (Lane, Wyo.) Mukden, Manchuria, appears to have moved from 7.670A and may be the station now heard on 3.650A. (Radio Australia)

Colombia — Radio Nacional, 6.200, Bogota, noted with call 2230. (Sams,

Ore.) HJDW, 5.055, Medellin, noted 1900 with station call; fair level in England. (Catch) HJEF, 4.768, Cali, "Radiodifusora del Occidente," is a *new* one noted evenings (*EST*); also *new* is HJFU, 4.797, Armenia, "La Voz del Comercio," also heard well evenings (*EST*). (Legges, N. Y., via URDXC)

Costa Rica—TIRH, 11.972, San Jose, is good level some days around 1300-1500. (Saylor, Va.)

Cuba—COCW is currently on *measured* 6.314V; noted 1928 with music. (Oskay, N. J.) *Radio Salas*, COBZ, 9.030, Havana, noted with call 2000. (Sams, Ore.)

Curacao—PJC2, 5.014, Willemstad, noted after 1910 with popular recordings and commercial announcements in *English*. (Catch, England)

Cyprus—The Near East Arab Broadcasting Station, Limassol, is now scheduled 2255-0130 on 6.135, 6.170, 6.790, 9.650; 0300-1000 on 6.170, 6.790, 9.650, 11.720; 1000-1400 on 6.135, 6.790, 9.650. All programs are in Arabic with news 2300, 0045, 0100, 0630, 1030, 1115, 1330; dictation speed news 0100 and 1115 (*except* on 6.790 which carries the General Program). (*WRH Bulletin*) The 6.170 outlet noted around 0000 in Arabic at fair to poor level; the 6.790 outlet was poor 0025 with Arabic music. (Kary, Pa.)

Czechoslovakia—Prague, now announcing as "The Voice of Peace," noted on 11.840 in *English* 0715-0745; announced 15.320 in parallel but was not audible in 19-m. band. Announced further *English* broadcasts daily 1400 and 1600 in the 25- and 48-m. bands. Noted in *English* 1400 on 6.170, 11.875. (Pearce, England) Heard on 15.320 at 0730 announcing as "The Voice of Peace." (Fried, Mich.) At 1400 in *English* on 11.875. (Bellington, N. Y.)

Denmark—OZF, 9.52, Copenhagen, noted 2130 signing off *English* for North America; weak in Iowa. (Lund)

Dominican Republic—HI8Z, 5.023, Santiago, moved here from 5.030. (Legges, N. Y., via URDXC)

Dutch New Guinea—*Radio Hollandia* has moved back to its former 7.170 spot. (Cushen, N. Z.)

Ecuador—HC2CA, Salinas, was noted recently on a *new* channel of 6.902 at 2100. (Machwart, Mich.)

Egypt—Radio Cairo has settled down on 9.715 (from 9.555). (*WRH Bulletin*; others). Noted more recently opening 1400 with news; usually closes around 1600; several monitors report this one with news also 1430. In verifying for Bellington, N. Y., listed frequency of 9.715 at 1345-1700, power 6 kw.

El Salvador—YSUA, 6.100.3, San Salvador, noted 2005 with music. (Oskay, N. J.)

Ethiopia—Radio Addis Ababa, ETAA, 15.047A, noted Saturdays and Sundays around 1235-1303 sign-off; good signal in Louisiana. (Locke)

Finland—Helsinki, 15.190, noted with news 0715-0724; announces 9.55 and 17.800 in parallel and that repeat broadcast at 2200 (for USA) is on these three outlets. (Pearce, England)

France—Sanderson, Australia, re-

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ports Paris on 21.740 with French program of news and music 0615.

Paris, 5.97, heard 1642-1645 with French lesson; signed off 1645 in Portuguese. Noted on 7.24 at 0845-0900; at 0900 identified in *English* and announced *English* service for Sat. and Sun 0800-0900 on that channel. (Rodger, Scotland) Paris noted on 9.560 and 9.680 at high level around 2000; signed off 2030; *no English*. (Niblack, Ind.) Paris, 9.755, is noted around 1300 with a United Nations broadcast. (Leary, Ind.)

French Equatorial Africa—Radio Brazzaville, 11.970, noted with news 1745-1800. (Ripton, N. Y.) Is also parallel on 9.440 at that time. Heard by Guterman, N. J., with news around 1545-1600, then in French.

Heard on 9.440 with program of French news and music 0045. (Sanderson, Australia.) The 11.970 outlet noted with news 1200-1215. (Bishop, Ohio)

An outlet of this country on 15.596A was recently heard with news in French 1400 and signing off with "La Marseillaise" 1500. (Kary, Pa.) May be *Radio Chad*.

French Morocco—Radio Maroc, 6.006, Rabat, noted 0200-0330 fade-out with all-Arabic session. (Saylor, Va.)

French West Africa—Radio Dakar is reported on 9.71 afternoons, parallel with 11.896A, to closedown 1800. (Bellington, N. Y.; others)

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TGNA is still eager to receive reports—especially from USA—on its new 11.850 outlet. (Boice, Conn.)

Haiti—The French program of VOA at 1230-1300 to Europe is rebroadcast at 1700 from *Radio Citadelle*, 6.300, Cap-Haitien. (*WRH Bulletin*) 4VRW, 9.950A, Port-au-Prince, noted 1545-1600; announced in both French and *English*; program was mostly in French. (Niblack, Ind.) 4VM, 6.012, Port-au-Prince, noted 2131 with *English* identification, then anthem; closed 2132. (Machwart, Mich.)

Holland—PCJ, 21.480, Hilversum, noted with news 0545; PHI, 11.730, heard with Dutch news 2230; PCJ, 15.220, heard with news program 0530. (Sanderson, Australia) Noted on 9.59 with news around 1510. (Rodger, Scotland)

Honduras—Radio Monserrat, 6.675A, Tegucigalpa, noted with call 2130. (Sams, Ore.) San Pedro Sula, 6.351, noted closing one night at 2333; identifies in *English* frequently. (Machwart, Mich.)

India—AIR, 5.960, noted with news in Hindustani 0830. (Sanderson, Australia) Delhi, 11.85, heard often at 1830 sign-on; leaves air 2000 but returns 2030; news at 1930, 2130. (Niblack, Ind.) Pearce, England, notes the 5.960 channel 1430 with slow news in Arabic, and signing off 1455 after call of "Huna Delhi."

Indo-China—Radio France-Asie, 9.754A, Saigon, noted 1000-1032 when signed off with "La Marseillaise;" another day closed 1000. (Pearce, England) By now may have *moved* from 11.830 to (proposed) 11.925 to escape QRM. (Cushen, N. Z.) Saylor, Va., reports *Radio Hue*, 7.205, at good level around 0200-0300 some days with all-French program.

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(*Continued on page* 139)

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The Leak-Proof Roof Entrance for TV and FM Transmission Line and Rotator Control Cable

Here's the new ROOF-THRU, another MOSLEY product for BETTER TV PICTURES Through More Efficient Installation. ROOF-THRU provides the easiest and most practical method of bringing in lead-in for concealed-in-wall installations using MOSLEY Flush Mounted Sockets.

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Cat. No. 624 MOSLEY ROOF-THRU.
List Price.....$5.84

See the ROOF-THRU and MOSLEY Flush Sockets at your jobber.

MOSLEY ELECTRONICS
2125 Lackland Road, Overland, Missouri

Adapters for Servicing

(*Continued from page* 51)

16 mm sound projectors may also be tested with the proper plugs. *Jones* and *Cannon* plugs seem to be popular on this equipment, and you may have just what you need around the shop. Even "professional" theater sound equipment may be hooked up to this gadget.

Record-changer adapters, to connect phono motors, pickups, electrical "rejects," etc., can also be made. The special motor plugs may be connected to a short length of cord and a plug and used to adjust these units. Changers using special plugs are easily checked with this setup.

Many quick tests may be made with this system. To check a speaker for opens, hook up two leads to the voice coil jacks and touch them across the suspected speaker. Similarly, with output transformer primaries, hook up the bench speaker transformer and touch it from plate to screen of the output tube. Distortion and rattles suspected of originating in the set's speaker may be traced by substituting the bench speaker. Frying noises, caused by electrolysis of winding, field, or output transformer, may be traced down by connecting the substitute in place of the suspected unit. Use the substitute field to replace an open filter choke, so that you can operate a set long enough to find other possible defects and make a complete estimate on the job. If you think it is worthwhile, install a set of resistors and a tap switch, as a resistor substitute. Filter condensers might be added too.

Once you have the basic unit installed, you'll find new uses for it every day. A few feet of test lead wire, a pair of tips, and a plug are all you need to make up an adapter for any set. The ones suggested in this article are more or less standard and will fit about 90% of all sets. Here's a helpful hint on keeping the adapters straight. Get several of the L-shaped screw-hooks, cup-hooks, etc., and screw them into a convenient wall. Hang up to three adapters on each. Put the most frequently used ones at your end of the bench, the others at the other end. On an average, these gadgets will save you from five to fifteen minutes on every job and, at today's prices, that's really worth-while! —30—

EMERGENCY NET MEET

THE Western Pennsylvania Emergency Network, comprised of hams who have volunteered to serve as a communications link during war or some other period of national distress, will hold its annual hamfest April 20th.

Over 1000 persons are expected to attend this gathering which will feature a variety of competitive events.

Full details on this event are available from John Duggan, W3OBO, chairman of the hamfest, 1400 Creedmoor Ave., Pittsburgh 26, Pa. —30—

Crystal Diodes

(*Continued from page 71*)

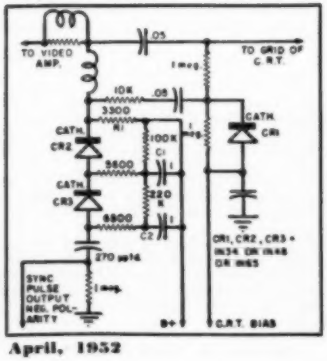
as a slow variation of background illumination; this combined with the shift in the direction of white results in visible retrace lines to such an extent that this circuit is not recommended except where compactness and low price are more important than generally acceptable picture quality.

The defects of the circuits of Figs. 2 and 3 may be overcome by the use of separate crystals for sync separation and d.c. reinsertion, plus a few additional components. This improved cascade type germanium diode separator is shown in Fig. 5. These refinements permit a larger sync pulse output and better separation because the circuit may be optimized as a sync separator. The d.c. restorer diode is shown in this circuit as a design feature only; it plays no part in the sync separating function. It is necessary to provide individual long time-constant biasing networks and the clipper circuit should be directly coupled to the video amplifier output.

The peak conduction of germanium diode CR_3 during the sync pulse interval produces a d.c. component. This charges the condenser in the biasing network, and this d.c. component cuts the diode off in the time between pulses.

The biasing network condenser loses a small portion of its charge during the line scanning interval, but this charge is replenished during the successive pulse intervals. The resulting diode current through the added series resistor produces a voltage pulse which corresponds to the desired sync pulse. It is this pulse which appears at the cathode of CR_2 with all the video com-

Fig. 5. Cascade separator with d.c. reinserter. R_1 is the video amplifier plate load resistor and should be approximately 3300 to 3800 ohms. C_1 and C_2 should be 1 μfd. electrolytics. The value of these units will affect the sync pulse amplitude and the video leakage. They may be as small as 5000 μμfd. in which case the leakage will approximate 5% at 40 volt peak signal. The ratio of output voltage to input voltage is .80 for a cascade pentode type circuit and approximately .65 for this cascade-type germanium diode circuit.



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HAS 4 MICROVOLT SENSITIVITY—10 times any other TV receiver. Will pick up distant stations without use of boosters or special antenna arrays—and with less noise. Will operate any tube including 24", greater brilliance, improved keyed AGC circuit, (eliminating flickering and fading). Uses the best materials with a high factor of safety to insure trouble-free operation. STD RTMA GUARANTEE free replacement of defective parts or tubes for 90 days. Completely factory wired chassis ready to operate with 12" P.M. Speaker.

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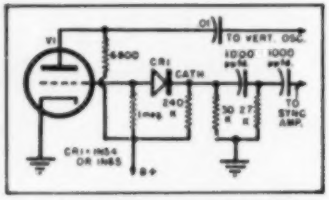

Fig. 6. Vertical pulse separator with an amplifier, an inverter, and a limiter.

ponents stripped off; hence, only the sync pulse remains.

To improve the pulse stripping action over the wide range of video signals the germanium diode CR_1 is connected in series with CR_2. CR_1 has its separate biasing network. Since the clipping level of the second crystal is determined by the partially separated sync pulse output of CR_1 the combined action of the two crystal diodes is cumulative. The final sync pulse output is relatively free from video components at all the usable signal amplitudes; the separation is quite sharp.

It may be of interest to mention that the crystal diodes operate with fixed d.c. bias obtained partially from the plate load resistor of the video amplifier output pentode. By reducing the dynamic resistance of the crystal diodes during conduction this biasing action makes available a sync pulse of fairly large amplitude. Another advantage in using crystal diodes in this type cascade circuit is the low capacitance of the crystals which makes it possible to load the video output circuit with the sync clipper, without necessitating any changes in the high frequency compensation network.

Vertical Pulse Separator

The function served by the circuit in Fig. 6 is to provide six large-amplitude, steep-fronted positive pulses for vertical synchronization. The circuit is so designed that these pulses coincide in time occurrence with the serrations in the vertical sync section of the standard RTMA synchronizing signal.

The trigger pulses of the vertical deflection circuit have sharp rising wavefronts and are of relatively large amplitude. Hence, this circuit will provide stable vertical sync without critical adjustments or components.

The conventional vertical sync integrator is replaced in this circuit with a two-stage differentiating network with a specially selected time constant. The differentiator is supplied with mixed horizontal, vertical, and equalizing pulses, all in positive polarity. The swing of the inverse voltage at the trailing edge of the broad vertical sync pulses is approximately three times the amplitude of the swing of the inverse voltage at the trailing edges of the horizontal pulses.

The biased series-connected germanium diode crystal clips off the horizontal components, and the vertical pulses which remain are of negative polarity; these are amplified, inverted, and squared in the triode pulse amplifier stage. The germanium diode clipper element provides excellent pulse discrimination because it has less capacitance than the interelectrode capacitance of the best tube type diodes now available.

This is an important point because any capacitance in shunt with the clipper diode is likely to bypass the high frequency components of the horizontal pulses on through to the vertical pulse amplifier. This would impair sharp pulse separation, cause faulty interlacing, and sometimes produce crosstalk between vertical and horizontal sync signals.

The next and concluding section of this series on germanium crystal diodes will deal with a.f.c., the horizontal phase comparator, and a.g.c. circuits.

(Concluded next month)

TECHNICIANS ORGANIZE

A NEW technicians' group, which is an outgrowth of the old Radio Technicians' Association, San Fernando Valley Chapter, has been recently organized under the name "Society of Radio and Television Technicians Inc."

The Society received its charter and organization papers from the state of California in January and has already inaugurated an impressive program for its members.

Dinner meetings are held twice monthly and the programs are designed especially for the practicing technician. Except for a short business session at the beginning of each meeting, the entire evening is devoted to technical matters.

Technicians, jobbers and their salesmen, and apprentices in the San Fernando Valley who are interested in joining such a group should contact Dell Davis, chairman of the public relations committee of the Society, at 1745 W. Glenoaks, Glendale 1, California.

—30—

HAM CONVENTION

THE Oregon Amateur Radio Association will hold its annual convention at the Osburn Hotel in Eugene, Oregon, Saturday and Sunday, April 26th and 27th.

All radio amateurs and their XYL's are cordially invited to attend. The registration fee for licensed hams is $6.50 and for all non-hams $2.50. Only licensed hams will be permitted to participate in the drawings for prizes.

The program will include a demonstration of screen grid modulation by John Reinhartz using his portable 1 kw. Eimac transmitter, a hidden transmitter hunt, a "swapfest" for unused radio gear, a demonstration of electronic control of ship models, and the prize drawings.

Hams may register by mail by addressing their checks or money order to "Wink" Wintler, W7KL, Eugene, Oregon.

A large turnout is expected for this event and persons living in the vicinity of Eugene are urged to make their reservations early to insure accommodations at the convention.

—30—

NBFM Adapter

(Continued from page 59)

ing diagram, the adapter may be wired into the set. Plate and filament voltages may be obtained from the receiver's power supply as the current requirements are low. The input signal is taken from the same point as the second detector connection.

The adjustment procedure is as follows. With the changeover switch in the AM position, tune in an NBFM signal, centering the carrier, i.e., the point of minimum audio between the two sideband tuning points. Next switch off the a.v.c. of the receiver and switch on the adapter. Tune the gating-grid circuit for maximum audio output and minimum distortion and then retune the secondary of the last i.f. transformer for maximum audio and minimum background noise.

Next tune in a weak AM signal and reduce the r.f. gain control until the modulation is audible even though distorted. Proceed to the adjustment of the cathode bias for optimum limiting action, that is, maximum output on the AM signal. Once these adjustments are made, the adapter is ready for operation. Finally, peak the compensating condenser that peaks the last i.f. transformer with the switch in the normal or AM position. The adapter is now ready to go.

Those who like to experiment can try out this type of circuit using one of the standard heptode mixer tubes (6SA7, 6BE6, or 6SB7Y) instead of the 6BN6. With heptodes, the oscillator grid (pin 2) is used as the signal or limiter grid and the normal signal grid (pin 6) as the gating or quadrature grid. To insure efficient operation, the oscillator grid (pin 2) should be returned directly to the cathode through a 100,000 ohm resistor and the gating grid returned to ground by means of the tuned circuit. Operational bias can be fixed by means of a 330 ohm cathode resistor, suitably bypassed to ground. The limiting action with the heptodes is less noticeable than with the gated-beam tube, but in all other respects the former will operate adequately in the adapter. –30–

SOCKET PUNCHES

By L. H. TRENT

WHY do extra work when using a socket punch? Here is an idea that will save your nerves and possibly some skinned knuckles.

Drill a normal pilot hole and thread the punch parts through the metal. Tighten the punch drive screw by hand until the punch is seated firmly at the correct place on the chassis. Tighten the screw about two turns with a pliers. Then use a woodworking brace to drive the screw in the punch.

The chuck of a carpenter's brace has square jaws, while a hand or motor drill is equipped with a triple jaw and cannot be used. A few drops of heavy oil on the driving screw will cut the friction. –30–

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A basic course on antenna theory combined with a complete handbook on antennas and their installation. Shows how to pick the right antenna for the site, determine the best position for it, install transmission line for maximum efficiency and all other practical details for getting the most out of the antenna system.

Noll's TV FOR RADIOMEN

Explains very clearly and fully all basic principles of television reception, the essentials of TV transmission, and the construction and operation of each part of modern TV receiving systems; and gives step-by-step instruction in installation, adjustment, alignment, and basic trouble-shooting procedures. A basic book for anyone in television servicing, noted for clarity and completeness. Here are all the fundamental why's and how's by a man known throughout the country as a leading authority on the technical aspects of television.

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Tube Complement: 28 tubes 3 rectifiers 1 CRT

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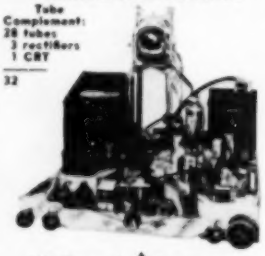

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Mattison Television & Radio Corp.
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Within the Industry

(Continued from page 28)

yard, Culver City, California. Increased warehouse space enables the Division to carry larger stocks and the modern facilities provide for more rapid service . . . **P. R. MALLORY & CO.** is undergoing a half-million dollar expansion program in which 62,000 square feet of manufacturing space will be added to facilitate production of components for the Armed Forces . . . **SIERRA ELECTRONIC MANUFACTURING COMPANY** has just completed a 10,000 square ft. addition to its plant at 1050 Brittan Avenue, San Carlos, California . . . **HOFFMAN RADIO CORPORATION** has added 38,000 square feet of floor space to its No. 5 plant at 6200 South Avalon Boulevard, Los Angeles, California . . . **MAGNA ELECTRONICS COMPANY** recently moved from Los Angeles to 9810 Anza Boulevard, Inglewood, California . . . **VARIAN ASSOCIATES,** 99 Varian Street, San Carlos, California, is planning to erect a new million dollar research laboratory in South Palo Alto . . . Retaining its Los Angeles factory at 6809 Victoria Avenue, **INTERNATIONAL RECTIFIER COMPANY** has just opened a new plant and administrative offices at 1521 E. Grand Ave., El Segundo . . . **AIRTRON, INC.** has completed its transfer of administrative quarters to enlarged suites at 20 E. Elizabeth Ave., Linden, N. J. Acquisition of space brings the company's occupancy up to 100,000 square feet in Linden . . . **SPRAGUE ELECTRIC COMPANY** has established engineering offices at 11325 Washington Boulevard, Culver City, California to better serve the growing electronics and aircraft industries of Southern California . . . **GENERAL ELECTRIC COMPANY's** pioneer venture in educational and industrial research cooperation is revealed in their plans for the new *General Electric* Advanced Electronics Center at Cornell University, Ithaca, New York . . . **CLIPPARD INSTRUMENT LABORATORY, INC.** is moving to a new 21,000 square ft. plant now under construction at 7350-7390 Colerain Avenue, between Mt. Airy and Groesbeck, Ohio, to keep pace with the increased demand for electronic equipment.

• • •

THE 1952 PARTS SHOW which will be held in Chicago at the Conrad Hilton Hotel May 19 through 22, has set up a detailed and explicit list of qualifications for attendance with three days set aside for distributors who handle a full and comprehensive line of component parts and equipment, and a fourth day for industrial buyers, industrial engineers, government agencies, and those who fit into special categories in the electronic distribution field.

"Special guests," as such, will be entirely eliminated and all persons attending will know well in advance of the Show on which days they may be admitted. Press badges will be limited to working editorial members of the press. Advertising executives will be admitted under the auspices of the member-exhibitor companies they serve.

The Parts Show is not open to the public.

• • •

NARDA, the national trade association of appliance and radio-TV dealers, has announced that local organizations of retail appliance and radio-television dealers will receive specially compiled reports for their exclusive use on the costs-of-doing-business in their areas as a part of the nation-wide annual survey conducted by the trade group.

The association points out that there will be no charge or obligation for these special studies but it is necessary that at least 20 dealers in each area participate in order to get an adequate sampling of that territory. This is the first time in the five years that the surveys have been made that individualized studies will be conducted.

Local groups who wish to participate in this survey are asked to contact NARDA headquarters, 1437 Merchandise Mart, Chicago so that questionnaires may be forwarded without delay.

• • •

J. J. SAMUELS has been named general sales manager of *Fidelity Tube Corporation* of East Newark, New Jersey.

He was formerly associated with *Sheldon Electric Company* as director of sales and a member of the board of directors. He has a diversified background in the television and electronics industry, having been connected with *RCA, Bendix Radio,* and *Tele-Tone* before joining *Sheldon,* and subsequently, *Fidelity.*

• • •

STEVEN E. LASEWICZ has been appointed production manager of *The LaPointe-Plascomold Corporation,* Windsor Locks, Conn. . . . **STANLEY W. CHURCH,** mayor of New Rochelle, New York, has been elected vice-president in charge of public relations and a director of *Sightmaster Corp.* . . . **WILLIAM E. FARRAGHER,** account executive of *Arthur Towell, Inc.,* has been named assistant advertising manager of *Magnecord, Inc.* of Chicago . . . **ABE KALINSKY,** designer and production consultant in the transformer field, has been appointed general manager in charge of production for *Heldor Manufacturing Company* of Bloomfield, New Jersey . . . **W. S. ALLEN** has been named general manager of the Electrical Division of *Olin Industries, Inc.* He will be responsible for the operation, production, sales, research, development, and quality control of the division's products manufactured in the company's New Haven, Conn. and Covington, Tenn. plants . . . **ARTHUR M. WENGEL,** electronics research engineer for the *Ray-*

O-Vac Battery Company of Madison, Wisconsin, died of a heart attack recently. He had been on the company's staff since 1932 . . . **ROBERT R. PORTER** has been named vice-president and sales manager of the *Sperry Corporation*. He was formerly president of the company's *Ford Instrument Company Division* . . . *Erie Resistor Corporation* has named **BYRON B. MINNIUM** to the post of vice-president and general manager of the Electronics Division and **GORDON GROTH** vice-president and general manager of the company's Plastics Division . . . **RICHARD F. DOOLEY**, vice-president of *Admiral Corporation*, has retired after serving the company since its founding in 1934. He will continue as a director and consultant for the company . . . **WILLIAM H. HAPPE, JR.** is the new works manager of the Electronics Division, *Curtiss-Wright Corporation* of Carlstadt, New Jersey . . . **CHARLES H. WIRTH** is the new engineering representative for the *Audio & Video Products Corporation* . . . **PAUL GAYNOR** is the new vice-president in charge of merchandising for *CBS-Columbia Inc.* He will be responsible for the company's merchandising, sales promotion, advertising, and publicity activities . . . **JAMES W. KELSO**, former United Nations artist-designer, has joined *Packard-Bell Company* as chief cabinet designer.

* * *

JOSEPH G. DeVICO has been appointed to the new position of director of advertising and sales promotion by *Majestic Radio & Television*, Division of *The Wilcox-Gay Corporation*. He formerly served as advertising manager of the *Majestic* division.

In his new position, he will direct advertising and sales promotion for the company's line of radios and television receivers and supervise promotion activities for *Wilcox-Gay* "Recordio" equipment.

Mr. DeVico has been with the present organization for six years, having joined the company when it was known as *Garod Electronics Corporation* in October 1945. —30—

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379	412	488	440	663
379	413	490	442	664
317	414	492	444	666
379	416	493	444	668
381	429	493	445	668
382	430	494	446	670
384	432	495	449	670
386	433	496	450	672
387	434	497	451	674
388	435	498	452	675
390	437	503	452	675
391	438	504	453	676
392	441	507	455	677
394	442	509	455	677
396	445	511	456	679
398	446	512	457	680
401	478	514	459	501
403	481	518	459	501
405	483	535	461	505
407	484			
409	485		09c ea. or	10 for $9.00

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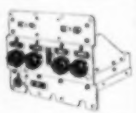
TUNER FROM NAVY "BN" EQUIPMENT



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Klystron Oscillators

(*Continued from page 56*)

the circuit by the collector. The entire assembly is enclosed in a vacuum tube.

The electron gun directs a constant intensity stream of electrons through the buncher grids. The electric field, due to the cavity action between these grids, is varying sinusoidally. Accordingly, some electrons are accelerated, some maintain the same velocity, and others are retarded as they pass through these grids.

The electrons emerge from the buncher having various velocities, but the electron stream still has an essentially uniform density. The electrons then flow through a field-free "drift space." It is assumed, for simplicity, that in this region there are no d.c. or r.f. fields, and that any space-charge effects are negligible.

In this drift space, the electrons that were speeded up by the buncher begin to catch up with the slower moving electrons ahead of them. In a similar manner, the electrons which were slowed down by the buncher lag behind more and more until they are overtaken by electrons that left the buncher at a later time. This bunching process, similar to that occurring in the positive grid oscillator, eventually results in the breaking up of the electron beam into groups, or bunches, of electrons. These bunches of electrons are separated by regions in which there are comparatively few electrons.

The electrode arrangement thus far described is useless in the sense that no output signal has been obtained. In principle, an ordinary plate might be installed at the end of the drift space and be used to collect the signal from the electron beam. The voltage of the plate would rise and fall as it was struck by the bunches of electrons. Unfortunately this method of signal collection is not practical because the frequencies at which velocity modulated tubes operate are so high that stray capacity of the external load circuit would short circuit this energy.

Therefore another cavity is used to absorb this energy. This cavity, known as the catcher, is placed at the point in the drift space where maximum bunching occurs. The field of this cavity is so phased that it always is negative with respect to the bunched electrons. Hence energy from the bunched electrons is transferred to the catcher cavity and oscillations are sustained. The field is positive across these catcher grids during the time that there is a region of relatively few electrons and, therefore, little loss of energy occurs during this part of the cycle.

Proper phasing between catcher and buncher grids is effected by feeding back some of the catcher cavity energy into the buncher cavity. The remainder of the oscillator energy is coupled through a coaxial cable to the desired load.

After passing the catcher grids, the

electrons are moving at a greatly reduced velocity and are finally removed from the tube by a positive collector plate. The collector plate potential must be positive enough to attract all the electrons, but not so positive that electrons will strike at a high velocity and cause secondary emission. It is obvious that any random electron flow detracts from the over-all efficiency and stability of the system. Hence, the importance of effective removal of electrons after they have passed catcher grid.

In the second article on this subject, some of the practical aspects of klystron operation will be considered.

(Concluded next month)

SWITCH IMPROVEMENTS

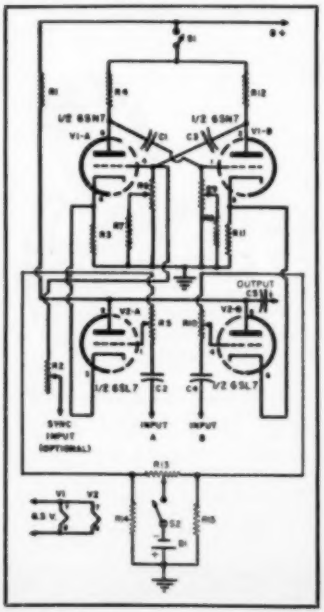
ONE of the serious shortcomings of the electronic switch described by James G. Arnold in the article "An Inexpensive Electronic Switch" (July, 1951 issue of RADIO & TELEVISION NEWS) is the difficulty of exactly superimposing the two waves.

Robert Cortner of Honolulu, Hawaii has overcome this difficulty by a simple circuit arrangement and an addition to the switch. The grounded ends of R_5 and R_{10} in the original design (Fig. 3, page 33) are returned to ground through 10,000 ohm resistors (R_{11} and R_{13} in diagram below). A 1.5 volt penlite cell furnishes the bias, while the 250,000 ohm resistor R_{12} allows the two signals to be balanced.

This circuit does not permit the gain of the two amplifiers to be reduced to zero but this is not objectionable except on signals of extremely high level. Signals of this magnitude are rarely encountered in this type of work.

—30—

Circuit changes for electronic switch.



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RADIO-TV Service Industry News

AS REPORTED BY THE

TELEVISION TECHNICIANS LECTURE BUREAU

WHEN authorized, u.h.f. television will present a host of new problems to the forces of the television installation and servicing industry. With from 2000 to 2500 telecasting stations possible in the new channels numbered 14 to 83, which cover the 470 to 890 mc. band, plus the stations that will be operating in the present v.h.f. band, television programs will be available in practically every city and hamlet across the country.

The first stations to be built will be located in present non-television areas. By the time these stations are ready to go on the air most of the receiver manufacturers will probably introduce their v.h.f.-u.h.f. combination sets with the circuits for receiving u.h.f. included in the receiver design. Quite obviously, the receivers that do not employ the continuous type of tuner will be equipped with the proper coils to receive the channels allocated to the area where the receiver is installed. Although receiver manufacturers have not divulged their circuit designs for u.h.f.-v.h.f. combinations, it is reasonable to anticipate many innovations in circuitry as field experience indicates the circuit combinations that are the most successful.

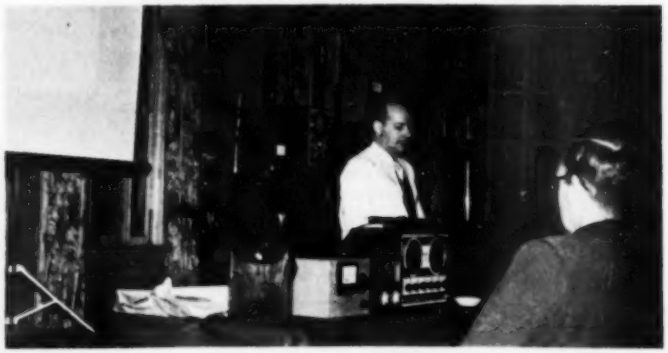
The immediate problem that will develop when u.h.f. is introduced into new areas is that of determining the best type of antenna to meet the peculiar needs of each newly-opened television area. *Radio Corporation of America* has been conducting exhaustive studies on u.h.f. reception since 1946 and its experiences provide a good practical basis for commercial u.h.f. installations.

The *RCA* studies began in July 1946, when experimental transmissions and tests were conducted in New York at 288 mc., 510 mc., and 910 mc. In September, 1948, equipment was made available and tested in Washington, D.C., at 504-510 mc.

After the Washington tests, the *RCA* u.h.f. project was moved to Stratford, near Bridgeport, Connecticut. Tests were made at this location at 530 mc., and are being continued at 850 mc. These studies include checks of transmitting and receiver antenna characteristics, receiver installation problems, effects of terrain and foliage, effects of weather, ground propagation, u.h.f. receiver converters, transmission lines, and many other factors.

It is interesting to note that the studies of indoor antennas of the built-in or cabinet types indicated that they were generally less satisfactory for fringe area use than outdoor antennas. A person moving or standing near the indoor antenna may cause a momentary deleterious effect on picture

Edward M. Noll of the Television Technicians Lecture Bureau explains the most important features of test instruments in television servicing in his lecture on "Test Instrument Applications." His lecture includes the demonstration of the alignment of a u.h.f. converter using presently-available service test units.



quality. Venetian blinds, awnings, and similar objects were also reported to affect the signal received with indoor antennas.

Eight antenna types have been thoroughly checked in the course of the *RCA* u.h.f. experiments. These included the fan dipole, two-stacked fan dipole, the stacked "V", the rhombic, the parabolic reflector, the corner reflector, the helix, and the six-element yagi.

In reporting on these tests the *RCA Service Company* stated that "Every installation site was thoroughly surveyed for optimum results before a u.h.f. antenna was installed. Often it was found that the fan dipole antenna did not produce sufficient pick-up. In such cases, the stacked "V" was substituted. If this proved inadequate, a corner reflector antenna was tried. If improvement was insufficient with substitution of antennas, the height of the antenna was increased. Where signals were received by reflection, the best position of the antenna was found to be critical as to orientation and height. A distance of a few inches horizontally or even vertically made a great difference in the picture quality.

"Where u.h.f. and v.h.f. antennas are installed, it is best to survey first for the u.h.f. channel, since it is more critical as to location. In many installations, the u.h.f. antenna may be mounted on the v.h.f. supporting mast. However, separate masts are sometimes needed."

The *RCA* u.h.f. experiments seem to indicate that changes may have to be made in the method now employed by many television installation and service contractors in handling receiver installations for u.h.f. reception. Many service contractors follow the plan of checking and aligning each receiver before it is delivered to the purchaser for installation. The installation crew handle all installation work up to the receiver input. Their installation reports include information on receiver performance after the installation is completed but the installation men do not make any adjustments on the set. A receiver technician follows up to make any necessary adjustments on the equipment.

During the early days of u.h.f., at least, it is probable that a member of the installation crew will have to be a fully competent TV technician, so that receiver adjustments can be made where necessary at the time of selecting antenna position, route of lead-in, etc.

Service Companies for U.H.F.

The metropolitan areas in which the majority of the present 107 v.h.f. stations are located will have their own peculiar problems with u.h.f. In some of the larger cities, for instance, the suburban districts will be in the fringe area of their local u.h.f. telecasting stations when the transmitting antenna is located in the center of the city. Reception problems due to signal black-outs from line-of-sight obstructions and reflections will be severe.

Television Accessories:

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AN-109A Whip Steel, 5 Ft. w/Base	1.50
AS-27/ARN-5 Ram's Horn, 110 MC.—USED	5.95
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AT-42/APT-5 or APT-1 Stub—115-150 MC.	6.00
AS-97/APQ-8 Spike with coaxial load in base	4.95
AS-61/ARN-5-Half-Wave Dipole—335 MC.	3.95

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FT-154 for BC-348 Receiver	$2.50
FT-470 Mounting & Clamp	1.00
MC-476 Maple Ball for aleron—f/Fairlead	1.00
MC-356 Wood Block—Fairlead	.75
M-235 Bobbin & 250 Ft. W-106 Antenna Wire	3.60
WT-7 Weight for Trailing Antenna	1.50

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TU-7-8-9-10-26 for BC-191-375 Used:	$3.95
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Autosyn Transmitter from LP-21A Loops, used with I-81 or I-82 Indicators. Operates from 26 Volt 400 cycle. With calibrated Dial and Correction Pointer. MC-567 $6.95 MC-217 $8.95

GEAR TRAIN MOTOR

Ball bearing, low inertia, reversible type. 588 RPM. Extra large gear, ⅝ RPM operates 26 Volt 400 cycle or 12 Volt 60 cycle. Removed from LP-21 Loops. Type—10047-2-A $4.95

MISCELLANEOUS

Leg and Seat Assy. for Hand Generator	$ 3.50
BC-230 Transmitter, with Tubes	4.95
T-20 ARC 5/BC-457 Trans.—4 to 5.3 MC.	
New:	14.95
R-1/ARR-1 Rec. f/conversion to 220 MC	4.95

CONTROL BOXES:

	NEW:	USED:
C-87/ART-13—f/ART-13 Trans.	$ 6.95	$4.95
MR-9C/Control Box f/RA-10 Rec. w/Mtg.	12.95	
BC-434 for ADF	5.95	3.95
BC-732 for Localizer	3.95	1.95
BC-646 Control Box f/BC-645	3.00	
BC-461 Reel Control Box w/Counter	2.95	

BC-223 TRANSMITTER

30 Watt transmitter with Crystal or MO control on four pre-selected channels. CW, MCW over frequency range 2000-5200 Kc. by use of plug-in coils. Complete with tubes and choice of one Tuning Unit (listed below). Less Mtg.—Prices: NEW: $32.50

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CABLE—Trans. to Power Supply	$2.00
TUNING UNITS: TU-17—2000-3000 Kc.; TU-18—3000-4500 Kc.; TU-25—3500-5250 Kc.	$3.80 EACH
Spare VIBRATOR & TUBE KIT f/PE-125BX	$ 5.95
PE-125BX POWER SUPPLY f/BC-223—12/24 Volt input; output 675 Volts 150 MA. NEW:	$4.98
SPARE TUBE KIT in metal box f/BC-223	5.00
OPERATING MANUAL for BC-223AX	1.00
SHOCK MOUNTING for PE-125	1.00
FT-173 MOUNTING for BC-223	2.50
BC-223 TRANSMITTER—Incomplete, for parts, front panel or meters. Price—As is:	$4.98

AERIAL WIRE	WIRE—HEAVY DUTY RUBBER COVERED
Aerial Wire—Phosphorous Bronze #16 Stranded. 200 lb test. Weather proof. 150 feet on Reel. BL-3 with Clips $1.50	3/#16—20 Ft. Length $1.20
	3/#12—10 Ft. Length 1.00
	1/#6—Shielded, 15 Ft. 1.50
	1/#6—Shielded, 7½ Ft. .75
	1/#2—Shielded, 8 Ft. 1.00
	1/#8—Cotton covered—Per Foot .06
	1/#14—Shielded, Rubber Covered, 50 Ft. Length $2.75
	Or Per Foot, at .06

BLOWERS:

115 Volt 60 cycle BLOWER (pictured), approx 190 CFM Dia. 2¾" intake; 2" outlet. Quiet running. Motor size: 2⅛"x3⅛". NEW—not Gov't surplus. Order No. RN-520. **$7.99**

DUAL BLOWER—Same as RN-520 above, except has blower assembly on each side of motor. Order No. RN-800 $12.95

POWER SUPPLIES:

VIBRATOR TYPE—6 Volt DC input; output 230 Volt DC 30 MA. filtered w/tube. Size: 6⅛"x4"x3⅛". Type $6.95

VIBRATOR TYPE—6 Volt DC input; output 230 Volt DC 50 MA.—not filtered—w/tube. Ideal for Command Receiver operation as receiver is filtered internally. Size 4⅛"x4⅛"x3⅛" $4.95

PE-157 POWER SUPPLY—2 Volt Vibrator Supply, operates from BB-54 2 Volt Battery mounted in case. Output voltage 1.4 V. ½ Amp 125 V. 50 MA. Less Battery, Speaker, & External Power Cord—with V. hour $4.95

BB-54 2 Volt Dry Battery $2.95

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0-150 Volt, 400 cycle, 2½" Rd.	$3.95
0-5 Amp. AC 2" Rd., 0-75A Scale	3.95
0-5 Milliamp DC 2½" Sq., 0-5 Scale	3.95
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0-500 Microamp, 2½" Rd., 0-15 & 0-600 DC Volt Scale	3.95
TUNING METER I-70B Reverse Scale, Weston #606 for Compass Control Boxes	3.95

PLUGS AND CONNECTORS:

PL-112 Plug for LP-21 Loop	$1.25
PL-P-103 Plug for BC-348	1.50
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M-359 Right-angle Coaxial Connector	.25

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INPUT:	OUTPUT:	STOCK No.:	PRICE:
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14 V. DC	375 V. 150 MA.	DM-375	8.95
14 V. DC	330 V. 135 MA.	DM-330	7.95
14 V. DC	500 V. 500 MA.	PE-50	14.95
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However, television installation and service contractors now operating successfully in the metropolitan areas will be able to adjust their operational procedures to handle the individual requirements of their u.h.f. installations.

The new service business opportunities that will stem from the expansion of u.h.f. telecasting will occur in the hundreds of medium and small-sized cities and towns that have u.h.f. channel allocations. These service businesses will probably follow a pattern of operation similar to the successful installation and service contract operations in present v.h.f. fringe areas. In fringe areas, of course, an outdoor antenna is necessary with every receiver installation. In most cases, the cost of the antenna system represents a substantial part of the total sale and in some installations it will equal the cost of the receiver. The personnel, facilities, and "know how" for making successful installations is a prime requisite for the fringe area service contractor with the result that his installation department has a larger staff than his receiver adjustment and servicing department.

Managers of successful service businesses in fringe areas now frown upon expanding their activities beyond a proven profitable radius from their headquarters. Distances vary in different parts of the country but, on an average, television service businessmen have found it inadvisable to handle installation and service contracts over twenty miles from their shops.

Many service businessmen feel that u.h.f. will usher in an era of small branch operations in which service contractors will establish sub-depots in the u.h.f. areas adjacent to their operating headquarters. It is felt that the activities of installation crews working out of a centrally-located shop can be profitably applied over a much larger area than the time of technicians who will handle the subsequent receiver service calls that will be required. The elements of time and distance are not so important on installations since these can be scheduled for the most economical routing of the crews. But time and distance are vitally important on receiver service calls since there is no way of predetermining when and where they will be required. The opinion that servicing depots may be the answer to adequate, efficient television service in small u.h.f. localities is based upon the facilities they would provide for prompt service by competent technicians backed by all of the know-how, planning, equipment, and stocks of a large central operation.

However, experienced service businessmen will move cautiously in expanding their operations. They have learned from costly experience that it is easier to expand than it is to contract a service business. They have learned that the first consideration is whether the firm is financially sound enough to finance an expansion pro-

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431.944	430.722	487.500	515.277	377.777	405.555	433.333	461.111
488.888	516.666	379.166	406.944	434.722	462.500	490.277	518.055
383.333	408.333	437.111	465.888	493.666	521.444	387.500	411.944
409.722	437.500	465.277	493.055	520.833	391.111	413.888	441.666
469.444	497.222	525.000	395.833	422.222	448.611	475.000	501.388
527.777	384.722	412.5	440.277	468.055	495.833	523.611	387.5
415.277	443.055	470.833	498.611	526.388	389.166	416.666	444.444
472.222	500.00	527.777	391.666	419.444	447.222	475.00	502.777
530.555	393.333	420.833	448.611	476.388	504.166	531.944	395.833
423.611	451.388	479.166	506.944	534.722	397.222	425.00	452.777
480.555	508.333	536.111	398.611	426.388	454.166	481.944	509.722
537.5	400.00	427.777	455.555	483.333	511.111	538.888	401.388
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gram, and second, what the enlarged operation will produce in the way of stable income.

Most radio service operators who entered the television installation and service business in the early days of TV grabbed all of the business they could get and expanded their activities far beyond their basic resources to finance them. Those who survived the subsequent recessions in installations and in annual contract business learned early that two of the most important elements in the continuing success of a service business were accurate records of all transactions and a monthly profit and loss statement prepared by a qualified accountant. This helps them to avoid the experience of the radio service operator who jumped into the television installation field in the early days, hired a couple of men, accepted all of the business he could get, and worked day and night to corral as much of the "easy money" in television as he could. At the end of a few months, when his cash in the bank did not measure up to the volume of business he was doing, he asked an accountant to look over his books and tell him what was wrong. He found that he had done approximately ten-thousand dollars' worth of business, but that it had cost him eleven-thousand dollars to handle it.

Price Cutting

Last summer, when television installation and service business was at rock bottom, some service contractors and dealers resorted to price cutting in an effort to get business. However, service businessmen who manage their businesses on the basis of accurate "cost of doing business" records did not resort to price cutting because it was obvious that the lower prices would force them to operate at a loss. Of course, the larger the volume of business that was brought as the result of cut prices meant an increasingly larger loss.

While it was hard sledding for these service businessmen who maintained the prices they had to get in order to do business at a profit to weather the summer slump, the benefits they received when business picked up more than offset their summertime losses.

Those contractors and dealers who cut prices found that once they cut their prices it was impossible to restore them to profitable levels after business picked up. In order to minimize their losses at the reduced prices, they had to cut corners wherever possible on installation and service. These practices showed up in a higher average of customer complaints and repeat calls.

On the other hand, the service businesses that maintained their prices gave excellent service and as business moved to higher levels, they were able to capture the cream of the installation and service business in their areas.

Service Association Activities

At their recent election, the Associated Radio-Television Service Dealers

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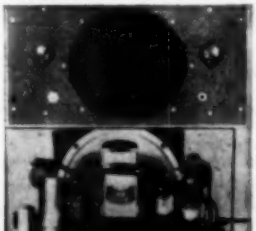

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of Columbus, Ohio, selected Fred Colton as president, Sam Oppenheimer, vice-president; George Dykes, secretary, and Fred Oberle, treasurer.

ARTSD, which celebrated its eighth birthday early this year, is one of the industry's most interesting and successful associations. It was probably the first service management association to be organized. Its membership is restricted to executives of the service dealers and TV contractor organizations whose business practices measure up to the Association's standards.

The Association works closely with local parts and set distributors. Four times each year they hold a dinner and business meeting with local distributors and through the exchange of ideas that such meetings encourage, the combined groups have been able to keep Columbus comparatively free from television service racketeers.

ARTSD cooperates whole-heartedly with the local Better Business Bureau and local newspapers have helped to publicize the organization and what it stands for in promoting efficient, dependable radio-television service.

Typical of the publicity that the Association has received from the local papers is the following extract from a column which appeared in the *Columbus Dispatch*:

"There are unscrupulous television and radio repairmen operating in Columbus at present. Not many but there doesn't need to be many to give the entire trade a black eye.

"They are careful operators, too, who function in such a way that the Better Business Bureau has heretofore not been able to blacklist them officially, nor can the police bring charges against them because, even in the most blatant cases of crooked practice, solid, brickwall evidence cannot be obtained.

"(The Better Business Bureau this week has released in its bulletin 'libel-proof' evidence against one or two organizations and plans to increase its efforts at publicizing unfair practices in the trade.)

"There is another way to stop these dishonest repair and service men. Some reputable service dealers in Central Ohio are formed into an organization known as the Associated Radio-Television Service Dealers to assure the public of a square deal. The organization began its ninth year last Wednesday night with a banquet at Grandview Inn, pledged to put the disreputable repairmen out of business.

"The TV set repair abuse has not been as vicious in this territory as in some of the larger cities but it has been bad enough. The only method that will root it out is organization, the members feel, and the Better Business Bureau wholeheartedly approves."

In addition to their activities on management problems in the operation of their service businesses, ARTSD committees provide four technical meetings per year for their members and members' employees. The Asso-

ciation cooperates wholeheartedly in all distributor-sponsored lectures and technical meetings.

The Master Television Servicemen's Association recently organized in Cincinnati, Ohio, now numbers more than fifty members. This group is developing an aggressive program of activities to provide their members with the outstanding lectures and training programs on TV installation and servicing. B. H. Sparks, service manager for *Ohio Appliances*, has been acting as industry liaison man for the new Association. —30—

CONVENTION TV

IN view of the importance and growing interest in the forthcoming national political conventions, the Long Lines Dept. of American Telephone and Telegraph Company is making every effort to expedite extension of network television facilities to provide service to Miami, New Orleans, Houston, Dallas, Ft. Worth, and Oklahoma City by July.

Originally scheduled for the "last half" of 1952, the network additions are being rushed to meet the earlier date. It was emphasized, however, that priority of construction and possible material shortages make it impracticable to assure the advanced dates.

The job involves the equipping of existing cables and providing new microwave facilities. —30—

TV SALES IN MEXICO

By EMIL ZUBRYN

MEXICO has had television a comparatively short time, but already abuses in sale of receiving apparatus are widespread. Television receivers are selling in the country at triple their worth and, on occasion, even five times the nominal retail value. This situation has been revealed by a study of import statistics covering television sets brought into the country in 1950.

The official Bureau of Statistics, according to tabulated data, shows that 6617 sets were imported in that year, with a value of 7,239,426 pesos ($837,858). This is to say that each set cost importers 1094 pesos ($126.47). However, the price to the Mexican public was fixed at 3500 pesos ($404.71). These figures apply to standard table model television receivers.

Cabinet, floor-model receivers show an even greater disparity in prices to the public. Of this type the Bureau figures show that 3595 sets were imported with a total value of 4,467,617 pesos ($515,972). A breakdown of per-set cost shows that the average cost to importers was 1242 pesos ($143.56). The price to the public for the cabinet receivers varied between 7000 and 10,000 pesos (from $809.20 to $1,156.00).

These figures graphically reveal why television has not as yet "caught on" in Mexico. Statistics for 1951 are lacking but a spot survey of retail stores shows that sets are still selling at prices far beyond the average public's reach. Due to public resistance prices have fallen off somewhat but table models still range around 5000 pesos while cabinet sets hover around the 7000 pesos and up mark. —30—

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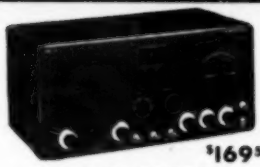
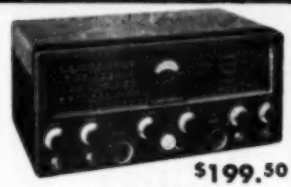


$169.50

New S-76 RECEIVER

Extra selectivity with double superheterodyne circuit. One RF, two conversion and 3 IF stages. Range 550-1550 Kc, 1.7-34 Mc in four bands. 8 tubes plus voltage regulator and rectifier. Complete with tubes, less speaker.

R-46 SPEAKER $19.95



$199.50

SX-71 RECEIVER

Double Conversion sharp selectivity, plus built-in NBFM at moderate cost. 11 tubes plus voltage regulator and rectifier. Low down payment.

R-46 Speaker $19.95

NAME YOUR TERMS • LOW DOWN PAYMENTS • PERSONALIZED SERVICE

HALLICRAFTERS RECEIVERS AVAILABLE FOR IMMEDIATE SHIPMENT

S-38B	$49.50	S-72 Portable	$109.95
S-40B	$99.95	SX-62	$289.50
S-81	$49.50	S-78A	$89.50
S-82	$49.50	S-76	$169.50
R-46 Speaker	$19.95		

Famous WRL RADIO REFERENCE MAP 25c

CU on 10-20 & 75 Meters

NEW LOG BOOK 25c

For mobile or fixed station. Spiral binding. Full column log listing all FCC required info. Will accommodate 1,525 stations. "Q" signals, phonetic alphabet, amateur international prefixes.

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Send for your copy today. Contains everything new in radio and television. Jam-packed with bargains. Leo I. Meyerson, W@GFQ

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- ☐ Radio Map
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- ☐ SR-75 Info
- ☐ SX-71 Info
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World Radio LABORATORIES INCORPORATED

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WALKIE TALKIES $4.99 Complete Set of 2

—ELECTRONIC VOICE POWERED

POCKET SIZE

No tubes, batteries, adjustments, license or permit needed! Guaranteed to work anywhere up to ½ mile with extra wire. Swell for garage to house, etc.! Your own private, talk-listen phone. Not war surplus. Brand new. Solid Aluminum Case. Two complete units ONLY $1.00 deposit and pay postman $3.99 C.O.D. or send $4.99 for PP delivery. Limited supply. WIDWAY COMPANY, Dept. WRT-L, KEARNEY, NEBRASKA.

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PRINT YOUR OWN POST CARDS

The GEM STENCIL DUPLICATOR saves money... gets results quickly! Hundreds of uses for every type of business and organization. We ship the GEM complete with all supplies, Guide Board for accurate printing and 60-page Book of Ideas at the special low price of only $8.50 (a $15.00 value)

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Use the GEM FREE at our expense! SEND NO MONEY. Write and complete GEM outfit will be sent you postpaid. After ten days, send us only $8.50 or return the GEM. You must be satisfied! WRITE TODAY.

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WALKIE-RECORDALL ® lb. miniature BATTERY RECORDER-PLAYBACK

Continuous, permanent, accurate, indexed recording at only 3c per hr. Instantaneous, permanent playback. Picks up sound up to 60 ft. Records conferences, lectures, dictation, 2-way phone & sales talks while walking, riding or flying. Records in closed briefcase with "hidden mike"; Write for Detailed Literature.

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WITH THE RHOMBIC

Phillips DX-er

Actually proven in field tests to have higher gain in fringe areas than any other antenna in use today.

- NON-RESONANT... 14DB GAIN
- COMPLETE COVERAGE... CHANNELS 2–13
- REDUCES OR ENTIRELY ELIMINATES GHOSTS
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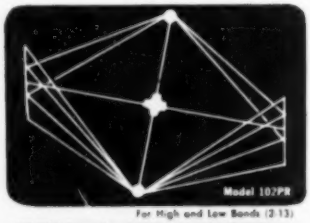
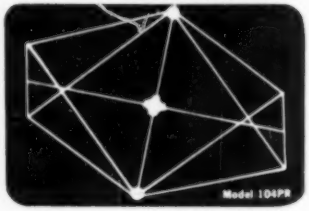
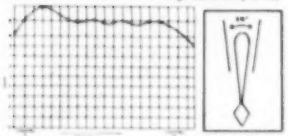


For High and Low Bands (2-13)



High Band Only (7-13)



Gain vs. Frequency Response — Response Pattern

Write Today for Technical Literature on this Outstanding Rhombic Antenna.

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RESEARCH LABORATORIES
717-RM NO. LAKE AVE., PASADENA 6, CALIF.

Manufacturers' Literature

Readers are asked to write directly to the manufacturer for the literature. By mentioning RADIO & TELEVISION NEWS, the issue and page, and enclosing the proper amount, when indicated, delay will be prevented.

"TECHNILOG"

University Loudspeakers, Inc., 80 S. Kensico Avenue, White Plains, New York, has issued a new general catalogue which will be of special interest to p.a. men and high fidelity enthusiasts.

Designated the "Technilog," this new 28-page publication carries both product and application data in simple and easy-to-use form. Curves, charts, typical circuitry, and practical discussions on such subjects as overload protection of loudspeakers, impedance matching, speaker baffles, phasing, reverberation, etc., have been included.

Copies of this new catalogue are available now at radio parts distributors or from the manufacturer direct.

TEST PROD PRODUCTS

United Technical Laboratories, Morristown, New Jersey, is offering a copy of its new two-color illustrated folder describing eleven "Klipzon" test prod products used by experimental and product development laboratories and radio and TV service technicians.

Each product description includes a brief text, illustration, and unit prices. The listings include high frequency crystal probes, streamlined test prods and leads, heavy duty test prods and leads, a.f. and r.f. shielded leads, miniprod connectors, test prod handles, heavy duty test prod handles, miniprod adapters, heavy duty adapters, longie adapter, and laboratory test leads.

The folder slips into a #10 envelope as a stuffer for distributor mailings to radio-TV service technicians and other users of test equipment.

"PALNUT" FASTENERS

The Palnut Company, 61 Cordier Street, Irvington, New Jersey, has issued a new four-page folder covering its line of fasteners for radio and television coils and shield cans.

Included in the new publication are illustrations of the fasteners, data on thread engagement, gripping points and supporting arms, specifications in tabular form, assembly instructions, and mechanical drawings.

Copies of this folder are available without charge on request.

INSULATION PRODUCTS

Complete descriptive information and technical data on the company's electrical insulation products have been included in a new 24-page catalogue recently issued by *Insulation Manufacturers Corporation* of 565 W. Washington Blvd., Chicago 6, Illinois.

The catalogue incorporates six bulletins, four completely new, on the various "Inmanco" products. Included are No. 499 which describes methods, materials, and applications for fabricated insulators; No. 499A which discusses the requirements, styles, and materials for ready-to-use motor slot insulators; No. 489 which gives information on the features of dispenser packaged cuffed motor slot paper; No. 443 which provides data on vulcanized washers; No. 280 on standard and special sizes and styles of hard maple wood motor slot wedges; and No. 441 which discusses the advantages and sizes of space-saving, curve-formed fiber motor slot wedges.

Copies of the individual bulletins or the complete catalogue containing all of the bulletins is available from the company's Publications Dept.

MILITARY-TYPE RESISTORS

Chicago Telephone Supply Corporation, Elkhart, Indiana, has issued a data sheet describing performance characteristics of its Types 95, 90, and miniaturized 65 military-type resistors.

Data on these high temperature, high stability, composition variables includes wattage and voltage ratings, humidity characteristics, leakage resistance, temperature coefficient, rotational life, and voltage coefficient as well as schematic drawings.

Copies of Data Sheet No. 155 are available without charge from the company.

BOOSTER BROCHURE

JFD Manufacturing Company, Inc., 6101 16th Avenue, Brooklyn 4, N. Y., is currently offering copies of a four-page brochure describing its line of "Tuck-Away" boosters.

The booklet is illustrated and carries complete data on the VB and SW models, including performance characteristics and specifications.

Copies of the "Tuck-Away" brochure may be obtained without charge from the advertising department of the company.

MINIATURE COMPONENTS

Southwestern Industrial Electronics Co., 2831 Post Oak Road, P.O. Box 13058, Houston 19, Texas, has issued a compact data sheet covering its new line of miniature transformers and reactors.

The data sheet carries complete details on these new hermetically-sealed, low frequency transformers and reactors. Information is provided on input, output, and interstage transformers,

and four types of reactors. The units themselves weigh 3 ounces and measure $\frac{15}{16}$" x 1$\frac{1}{8}$" x 1$\frac{7}{8}$" and are available in standard (±5%) or special (±1%) tolerances.

A written request to the company will bring a copy of this new data sheet without delay.

BIMETAL THERMOSTATS

Stevens Manufacturing Company, Inc., 69 South Walnut Street, Mansfield, Ohio, has just issued a bulletin describing its new neoprene-protected bimetal thermostats.

Hermetically-sealed MH disc type and CH strip type units are described along with information on suggested applications. The bulletin illustrates the operating principles involved and includes detailed dimensional drawings of the styles available for use where contamination is a problem. Ratings and construction data are tabulated for both types.

Copies of Bulletin L-4609 are available on request.

NEW ASA STANDARD

The American Standards Association, 70 E. 45th Street, New York 17, New York, has issued a new standard covering shunt and series condenser units for use on a.c. power transmission and distribution systems, at nominal frequencies of 60 cycles and below, for modifying the performance of the system at normal frequencies.

The new standard does not include high frequency units used in communication services and also excludes condensers used in connection with instrumentation.

Copies of the "American Standard for Capacitor Units" C55.1-1951 are available, at 40 cents each, from the ASA.

TUBE TESTER DATA

The Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland 8, Ohio, has issued a new four-page folder which illustrates and describes ten of its most recent dynamic mutual conductance tube tester models.

In addition to providing performance data on the various models, the booklet explains the principle of this type of tube testing.

At the same time the company has announced the availability of a new tube roll chart for *Hickok* tube testers, dated January 1, 1952. This chart includes all the new tubes on which data was available at the time of printing.

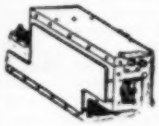
The roll chart is $1.00 while the folder (Form TT5) is free. Write direct to the company for either or both of these items.

MILITARY CONDENSERS

A new catalogue on military-grade paper dielectric condensers, made in accordance with the requirements of military specification JAN-C-25, has just been released by the *Sprague Electric Company*, North Adams, Massachusetts.

Sam's Surplus Sells For Less

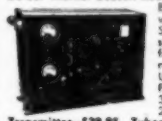
COMMAND AND/OR ARCS TRANSMITTERS and RECEIVERS



3-6 MC Receiver. Used $ 6.95 New 17.95
6-9.1 Receiver. Used $ 6.95 New 13.95
Triple Receiver Rack $1.95
V.H.F. ARC5 Transmitter or Receiver, Complete w/tubes Used $34.95
Used New
2.1-3 MC Transmitter with tubes 14.95
4-5.3 MC Transmitter with tubes 6.95
5.3-7 MC Transmitter with tubes 6.95
7-9.1 MC Transmitter with tubes 9.95 $19.95
3-4 MC Transmitter with tubes 18.95
28V Receiver Command Dynamotors $8.97

MODULATORS

BC-456 with Tubes, less dyn. 2.95
MD-7/ARC5 Plate Modulator 8.95
MD-7 Modulator Dynamotor, 28V 2.95
BC-433 Receiver—with tubes $24.95
MN-26C Compass Receiver 34.95 $39.50
MN-26Y Compass Receiver 34.95 39.50
BC-357 Marker Beacon Rec. W.O. Tube 8.95



BC-223 **Transmitter.** 30 watt. Ideal for Ship-to-Shore or Ham Rig. Crystal or MO control on four pre-selected channels. 2000 to 5250 KC. Use of 3 plug-in coils. Five tubes: 2—807, and 3—36, and TU 17—18—25 tuning units. **Transmitter—$39.95. Tubes—9.75. Tuning Units—$2.25. Amp Mater. No. 60-0-60 New—1.29.**

CIVIL AIR DEFENSE or 2 METERS

ARC-4, W/tubes. Good, used $29.95
522 Trans.-Receiver, W/tubes. Good, used 69.50
Modulation Transformer, BC-375. New 2.49
BC-375 Trans., 100 Watt Voice, CW, MCW, freq. range 200 kc to 12 mc, uses Plug-in Tuning Units listed complete with tubes, less Tuning Units $29.95
Tuning Units for BC-375 or 191 Trans:
TU- 7 4500- 6200 kc 2.49
TU- 8 6200- 7700 kc 2.49
TU- 9 7700-10000 2.49
TU- 10 10000-12500 2.49
TU- 22 & TU-26 200-500 kc each 4.50
FT-151 Shock Mounting for BC-375 or 191 2.95
BC-306 Antenna Loading 1.95
GP-7 Navy Transmitter: 100 watt master os. Can use on any freq. from 350-9050 kc. by using proper plug-in. With 1 tuning unit $13.33

LOOP ANTENNAS

DU-1 2 tube amplifier. New $25.95
MM-20-E New 7.95
LP-21 A New 16.95
Rotatable Loop Unit—Type MN-20E. 8" diameter—used with MN-26 Compass and RA 10 DB. By Bendix. Only $7.95
FL8 Filters—A's, B's, C's New 1.95
FL5 Filters— New .95
Hand Keys—J-38 New 1.19
TSC Transmitter & Receiver with 12V Power Supply and Cables. Good—used $179.50
Heineman Circuit Breakers 115 V., 20 amp. 1.39
115 V., 5 amp. .97
Prop Pitch Transformer, only new 6.95
RT-7PN-1 Transceiver w/o tubes. Used 9.95

"S" METER

"S" METER — **SAM'S SPECIAL.** Illuminated face (supplied with miniature lamp). Full scale reading of 5 ma. A standard value for most "S" Meter Circuits. Dia. across face—2½". Black bakelite face. Reverse-set pointer New $2.49
Vibrators—Mallory. For use on 12 V battery New $0.97

TRANSFORMERS

12V 24V 2am 110V primary $2.95
ARC-4 2 Meter Transceiver,tubes,good,used $39.95
BC-434 Control Used—$1.95 New 2.95
Code Tapes for TG-10 15 rolls. New 7.95
BC-906 Absorption Type Freq. Meter Range 150-225 mc. 0-500 DC Microm. Used $11.50
Field Phones E.E B's. Used $19.95 pr.
New $34.50 pr.
Relay, SP-ST. Leach 6 V or 12 V New 1.49

CRYSTALS—CR IA/AR

B150.000—8036.25—8001.43 $1.19 ea. 3 for $2.95

DYNAMOTORS

PE103 **New Case $29.95**
PE.103 **New,** Less Base 19.95
DM-32A Input 28V, Output 250 DC, .06 amps. Used 1.95
PE-73 29V @ 20 amps. output 1000V @ .350 amps. New 8.95
PE-77 14V @ 40 amps output 1000V @ .350 amps New 19.95
SPEC. 27V @ 400V 7.50 mil 750V 350 mil. New 13.95
PE-94 or SCR—522 24V. Used—$8.95 New 14.95
PE-94 Dynamotor only 4.95
DM-34 12V @ 2.8 amps. Output 220V @ .160 amps New 9.95
SPEC. 9V @ 450V output @ 80 ma. New 5.95
SPEC. 12V @ 320V output @ 80 ma. New 4.95
SPEC. 6V @ 250V output @ 80 ma. New 6.95
SPEC. 12V @ 440V output @ 200 ma. New 12.95
ARC-1 DY-9/ARC-1 Used 11.50
14 Volt Input—425 Volt Output at 163 mils. Starting Filter and Relays in base. Like New 3.95
RL-42B Antenna Reel Ass. Less wire. New 9.95

OIL CONDENSERS

Standard Makes—New		
2 mfd	600V	$0.49
4 mfd	600V	1.39
1 mfd	1000V	.49
3 mfd	4000V	7.95
.5 mfd	2500V	1.49
10 mfd	600V	2.95
2 mfd	2500V	3.95
2 mfd 5000V	$ 8.95	2 mfd 7500V 39.50
T-30 Throat Mikes		Used—3 for $0.50
CD-307 Head Set Extension Cord		1.19

HEAD SETS

HS-30 New $1.95
HS-23 Used—$1.95; New 2.95
Matching Transformer for HS-30 .49
RG-7U Coax Cable, 97.5 ohms foot .08
MIKE CHEST SET "F.1" button New .99

DECK INSULATORS

Bowl & Flange type. Heavy galv. metal flange—10½" dia. Porc. bowl set in rubber gaskets. Top bell—7¾" dia. Brass feed thru rod & insul. dist. between top bell and flange—6½". New $2.95

Cash with order. Prices subject to change without notice. California orders please include 3½% Sales Tax. Please include approximate postage—Excess will be refunded. What Have You in Surplus? Submit

ESEGE SALES COMPANY INC. 1306 BOND STREET, at PICO LOS ANGELES 15, CALIFORNIA

MAKE THIS YOUR HOME FOR IMPORTANT WORK UNDER IDEAL CONDITIONS!

- **TEST & INSPECTION ENGINEERS**
- **FIELD ENGINEERS**
- **ELECTRONIC ENGINEERS**
- **LAB. TECHNICIANS**
- **TV RECEIVER DESIGN ENGINEERS**

NEEDED TO WORK ON Radar, G. C. A., Mobile Radio, Auto Radio, Airborne Communication & Navigation Equipment, Television, Antennas, Microwave Equipment, Servo Mechanisms and Guided Missiles.

YOU BENEFIT FROM high wages, a modern, air-conditioned plant, paid vacations and holidays, group insurance and a good chance for advancement.

Housing immediately available in the beautiful suburban and country areas that surround the Bendix Radio plant.

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Bendix Radio

DIVISION OF BENDIX AVIATION CORPORATION
BALTIMORE 4, MARYLAND

Cash in on

TV Service Profits!

PRACTICAL TELEVISION SERVICING

By J. R. Johnson and J. H. Newitt
375 Pages, 230 Illustrations, $4.00

Good training for television service doesn't need to cost you a lot of money! This great book at only $4.00 is a complete guide that tells you step by step just what to do, what mistakes to avoid, what tools, parts and equipment to use—in short, *how to handle every phase of television receiver servicing promptly, efficiently and profitably.*

LEARN FAST! . . . LEARN RIGHT!

The authors of PRACTICAL TELEVISION SERVICING actually operated a TV service shop to get the specific, how-to-do-it information they now pass along to you in easily understood form. In addition to a clear explanation of how television work differs from radio, they show exactly how to perform all operations in trouble-shooting, diagnosing and remedying television troubles. You don't bother with needless theory. *They show you exactly how to do the work!*

Dozens of actual TV servicing case histories, service hints and common TV receiver troubles make the book literally worth its weight in gold.

Subjects include: *TV System Fundamentals; RF, I-F and Detector Sections; Video Amplifiers; Cathode Ray Tubes; Synchronizing and Sweep Circuits; Power Supplies; Antenna & Wave Propagation; TV Receiver Installation; Test Equipment and Adjustment; Wiring and Rebuilding Techniques; Color Television; Receiver Layout Diagrams*—and dozens more. In addition there are countless tips on such things as getting better fringe area reception; improving picture linearity; checking video response with a square wave; getting signals over a mountain and numerous others.

Read PRACTICAL TELEVISION SERVICING on our 10-day examination offer! Send coupon today!

READ IT 10 DAYS • at Our Risk!

Dept. RN-42, RINEHART BOOKS, Inc.,
Technical Division
232 Madison Avenue, New York 16, N. Y.

Send PRACTICAL TELEVISION SERVICING for 10 DAY FREE EXAMINATION. If book is O.K. I will then promptly remit $4.00 in full payment. If not, I will return book postpaid in good condition and owe you nothing.

Name .....

Address .....

City, Zone, State .....

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Price outside U. S. A. $4.50—cash only. Money back in 10 days if you return book.

The new Catalogue 21 is intended to serve as a reference guide for engineering and purchasing agents in specifying and buying condensers to meet the stringent performance requirements for various branches and agencies of the Department of Defense.

This 24-page booklet is available on business letterhead request only.

SOLDERLESS CONNECTORS

Complete specifications for solderless cable connectors have been included in the new catalogue sheet prepared by *The Workshop Associates*, Division of *The Gabriel Company*.

Included are dimensions and electrical characteristics on the company's Models W-50, W-60, W-80, and W-100 for RG-8/U, RG-11/U, and RG-59/U cable.

Copies of Form WA 54-164 may be obtained from the company at 135 Crescent Road, Needham, Massachusetts, or from radio parts distributors.

EDUCATIONAL BOOKLET

In answer to many inquiries from people outside the electronic industry as to the function of electronic parts wholesalers, the National Electronic Distributors Association has prepared a four-page brochure outlining the basic structure and functions of electronic parts distributors.

Covered in the pamphlet are sources of supply, material handled, customers served, type of employees, services rendered, the status of the electronic parts distributor, and his function in wartime.

Copies of the publication have been mailed out to manufacturers doing business through distributors and to manufacturers' representatives who sell for the suppliers and to distributors.

Individual copies of the brochure may be obtained by writing NEDA at 221 N. La Salle Street, Chicago 1, Illinois.

HEATH CATALOGUE

The Heath Company of Benton Harbor, Michigan, has just published a new catalogue covering its line of "Heathkit" test equipment and amplifiers.

This new 16-page catalogue includes schematics, inside photographs, application data, and circuit descriptions of the instruments. Among the units pictured and described are the company's probe kits, scope kit, voltmeter kits, audio and signal generators, electronic switches, condenser and tube checkers, signal tracers, impedance bridge kits, etc., in addition to receiver, tuner, and amplifier kits.

The company will supply copies of this 1952 catalogue to those making their requests direct to the firm.

"NEW PRODUCTS AND SERVICES"

The New York Journal of Commerce, 63 Park Row, New York 15, New York, has announced the availability of the 1952 edition of "New Products and Services," an 80-page compilation of time and money-saving innovations.

All of the year's most successful creations, ranging from electronic devices to self-watering flower pots, are described and cross-indexed in this illustrated booklet. Television is prominent among the items described. In addition to new models, the booklet describes a viewing aid based on the science of optics, a highlight control that produces an unusual three-dimensional appearance, and a variety of "custom built" sets incorporating unique features. There is also an explanation of the "telejector" which makes it possible to screen TV spots and shows in the office, and a description of a television set-on-wheels which can be installed in a private car and operated by means of a control panel mounted on the arm rest of the rear seat.

Copies of the publication "New Products and Services" are available from the paper at a cost of 50 cents each. Payment must accompany your order. —30—

Tape Duplication

(*Continued from page* 41)

tor," enabling the accommodation of both NARTB and RTMA reels. The duplicating equipment is so planned that it can service other diversified professional accounts in addition to *A-V Tape Libraries*. For example, broadcast stations may require copies wound on 10½" NARTB reels, while industrial sales-training programs may be required on 5" to 7" RTMA reels in order that they can be played on "home" type tape machines. Because of the difference between the inner diameters of reels, tensions of the take-up and supply sides of the tape transport become a factor in maintaining a constant linear speed of the tape over its full length of running time. Further, it may be necessary to have a 10½" reel on the supply side and a 5" or 7" reel on the take-up side. Rather than compromise the finished product, separate toggle-type tension adjusting switches for the supply and take-up motors were installed in the circuitry and mounted on the vu meter panels situated just above each duplicator.

Another operating idea that has been incorporated is the remote control panel which is mounted in a horizontal position on the table to the right of the relay rack. It consists of a bank of key switches which actuate a group of relays which enable the operator to start and stop all of the equipment at one time, or to "lift" any of the duplicators individually without affecting the motions or levels of the others.

As magnetic tape comes into greater usage and novel applications are found for this fascinating medium, the demand for mass facsimile copying of original tape recordings increases. The demand for *Audio-Video's* unique service has been increasing steadily since its installation a year ago—a strong indication of the trend in the industry. —30—

A-V Tape Library

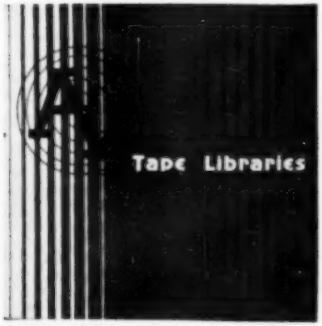
THE *A-V Tape Libraries*, 730 Fifth Avenue, New York, New York, now lists 26 available program reels in its current brochure. The firm will add at least two new reels each month. Many of the programs offer up to two complete symphonic works. The series is available in three basic forms: Single-track (Part 1 and 2, or both) at 7.5 inches-per-second (ips); Double-track (includes both parts) at 7.5 ips; and Double-track (includes both parts) at 3.75 ips. All programs are recorded on *Scotch* #111 plastic tape on 7" reels.

Outstanding is the *A-V* "Concert Hall" series of complete programs. These are re-recorded from tape masters (see page 40) on *Ampex* recorders. They provide music of high quality for the home or for FM broadcast. We have received several of the *A-V* tapes for review. They were reproduced (this month) through a typical hi-fi music system comprising a *Magnecorder* PT63JA, *Craftsmen* C500 amplifier, and *Altec* 604B speaker system. Single-track, 7.5 inch-per-second tape (*A-V*'s coding "A") was used. Data on these tapes appears in later paragraphs.

Tape Recording Industries (Magnetic Libraries)

We have received word from Dale Perry of *Tape Recording Industries*, Lansing, Michigan, that they are now perfecting their process for the duplication of music on multiple tape machines. The masters are recorded in the studios of "Potte Parisien" in the Champs Elysees, Paris and Magellan Studio which is also used by *Pathe Marconi* for the recording of well-known discs in France. Various combinations are used to cater to all types of musical interpretation. The con-

The neat carton used by A-V Tape Libraries to house its pre-recorded reels. The box is printed in black, yellow ochre, and ivory and provides a handy means of keeping the tapes in order and from damage.



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7193	.95	7Z4	.65
9001	1.79	12AU6	.79
9005	.35	12AT6	.74
15B	9.75	12AU7	.79
CK972	1.20	12BA6	.79
CK70	4.25	12BE6	.99
CRP-72	.95	12SN7	.99
E-1148	.25	12W6T	.85
HY-615	.25	25Z5	.75
HKR-72	1.30	35	.90
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5BP4	4.95	50B5	.99
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10,000	3	.55	.50
25,000	3	.85	.80
50,000	4	.90	.85
15	25	.95	.90
20	25	.95	.90
25	25	.95	.90
50	25	.95	.90
100	25	.95	.90
200	25	1.20	1.10
500	25	1.20	1.10
1000	25	1.30	1.25
3000	25	1.45	1.35
15,000	25	1.70	1.60
20,000	25	2.00	1.95
150 Switch	NO RN 2155 60	2.15	2.00
200 W Switch	50	2.15	2.00
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2500 MFD	3 VDC	.40	.40
500 MFD	12 VDC	.60	.55
25 MFD	25 VDC	.40	.35
40 MFD	25 VDC	.60	.55
50 MFD	50 VDC	.60	.55
1000 MFD	25 VDC	1.25	1.15
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*2	6	2	2½"	.55
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ductors are favorite broadcasters on the Continent and include such well-known personalities as Guy Luypaerts, Tito Fuggi, Adolphe Sibert (who has broadcast through Radio Miami), Jack Dieval (known in the U.S.A. as the "French Romantic Pianist"), etc.

The recording medium consists of special equipment built for this purpose with a frequency response of ± 1 db from 30 to 12,000 cycles. Both standard speeds of 7.5 and 15 ips are employed. Most of *Magnetic Tape Libraries'* tape masters are recorded with a single microphone pickup. This is the popular "Neumann Electrostatic" type.

We are informed that on the Continent they are using special duplicating machines which run off twenty copies at a time at high speed for 3.75 or 7.5 ips. Copies are made on French *Pyral* or on *Scotch* magnetic tape. These tapes are sold or hired on the Continent with a special exchange service for factories, stores, restaurants, etc. and each program is timed to run for approximately 30 minutes. Many of these masters will be shipped to the U.S. for duplication and these will be available in the very near future.

Beriant Associates (Concertape)

Another pioneer in the field of pre-recorded magnetic tapes is *Concertone*. In a letter received from *Beriant Associates*, 4917 West Jefferson Boulevard, Los Angeles, California, comes the report:

"We sent a questionnaire to a selected group of several hundred *Concertone* customers comprising a representative cross-section of professional, semi-professional, and amateur users. Of these about 65% replied and of the replies those interested in pre-recorded tape outnumbered the non-interested by eight-to-one. Most of those who had no interest were recording studios and other professionals who were in the business of recording tape themselves.

"We found that there was no agreement about the desired tape speed, reel sizes, or between single or dual track recording. The only approach to unanimity was in the preference for plastic tape over paper tape.

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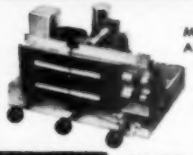

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"Because electronic dubbing must necessarily be done in small batches, the way the Scots make whiskey, it will be possible to supply recordings in the combinations of tape speed, reel sizes, and type of track that the various types of customers desire. The recording specifications also will be determined to some extent by the character of the music and its length. The longer the material, for example, the greater would be the need for larger reels, lower speed, and dual tracks."

We are anxiously looking forward to the opportunity of reviewing *Concertapes* as soon as they become available.

Tape Review

A-V (AUDIO-VIDEO) #1003
Part 1. Overture to Romeo and Juliet (Tchaikovsky)—Piano Concerto #2 in C Minor (Rachmaninoff)
Austrian State Symphony Orchestra, Kurt Woss, conductor; Felicitas Karrer, soloist.
Part 2. Piano Concerto #2 in C Minor (Rachmaninoff) Concluded—Etudes, Opus 25, Nos. 1, 2, and 3. (Chopin)
Austrian State Symphony Orchestra, Kurt Woss, conductor; Alexander Jenner, soloist.

A-V (AUDIO-VIDEO) #1005
Part 1. Symphony No. 4 in E Minor, Opus 98 (Brahms)
Austrian Symphony Orchestra, Kurt Woss, conductor.
Part 2. Symphony No. 4 in E Minor (Brahms) Concluded—Symphony No. 88 in G Major (Haydn)
Salsburg Mozarteum Orchestra, Paul Walter, conductor.

A-V (AUDIO-VIDEO) #1009
Part 1. Piano Concerto in A Minor, Opus 16 (Grieg)
Austrian Symphony Orchestra, Kurt Woss, conductor; Felicitas Karrer, soloist.
Part 2. Symphony No. 6 in C Major (Schubert)
Austrian Symphony Orchestra, Kurt Woss, conductor.

A-V (AUDIO-VIDEO) #1011
Part 1. Overture to Egmont (Beethoven)
Austrian Symphony Orchestra, Hans Wolf, conductor.
Part 2. Emperor Concerto for Piano & Orchestra in E Flat Major, Opus 73 (Beethoven)
Felicitas Karrer, soloist.

These tapes are all from *A-V's* "Concert Hall" series and provide one hour of program material. The tape masters were recorded under ideal conditions. Copies were made using the techniques described on page 40 of this issue. All are well suited for broadcast purposes and, in addition, are compatible with the finest home music systems.

A-V (AUDIO-VIDEO) #102
The Best Things in Life Are Free—Amarqura—I'm Confessin'—If I Had You—As Time Goes By—Come to the Mardi-Gras—Till the

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End of Time—Almost Like Being in Love—I'll Never Be the Same—Baia—Give Me the Simple Life

A-V (AUDIO-VIDEO) #103
Why Was I Born—Should I Tell You I Love You—Tomorrow is Forever—Dream—You're Mine—Holiday for Strings—Malaguena—Guilty—Two Loves Have I—Pavanne

Numbers 102 and 103 provide excellent material for dinner music. These tapes, which provide one-half hour of music, are superbly recorded and certainly come under the heading of "easy listening."

A-V (AUDIO-VIDEO) #602
Kiss Me Again—I'm Falling in Love With Someone—Moonbeams—A Kiss in the Dark—Sweetheart—Among My Souvenirs—Rose In the Bud—Remember—I'll See You Again—Lady of the Evening—Summertime

Number 602 bears the title "Organ Reveries." Apparently there was a lack of bass on the original recording and an attempt was made to equalize for the deficiency in dubbing. There is an over-abundance of bass on the tape submitted for review. Otherwise, an excellent tape. This is a half-hour program.

MAGNETIC LIBRARIES TAPE
1. Stories (Tales) From The Vienna Woods 2. Annen Polka (Strauss) 3. The Gypsy Baron —Potpourri
Orchestra of the Bremen Opera and Orchestra of the German Tape Productions.
1. Eine Kleine Nachtmusik 2. Notturno No. 3
3. Theme & Variations from the Trout Quintet
Members of the Bremen Philharmonic, Walter Bohle, pianist.

While excellent tapes, these could be improved by careful editing of the selections. There is a distinguishable "thump" during the silent part between the selections. Frequency response is excellent. Both tapes well performed.

In future appearances of this column, we will report on how the big-name recording companies are reacting to this new medium of home entertainment. We will also attempt to report on what the industry is learning about this new medium and on new and unusual applications of magnetic recording and, for the professional and amateur inventors, we will try to tip you off as to what needs inventing.

We invite other producers of prerecorded tape libraries to participate in this review. All submitted tapes must be single-track at 7.5 ips.

—30—

REEL REVIEW

A New Feature for RADIO & TELEVISION NEWS' Readers

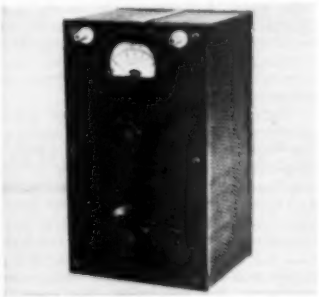
If present plans materialize RADIO & TELEVISION NEWS will bring you each month a complete listing and review of all the new tape recordings.

Obviously, if an insufficient number of tape recordings are released, it will be impossible to run this feature on a monthly basis.

What's New in Radio

(Continued from page 98)

designed to read power or impedance accurately at all impedances over the audio frequency range. This unit indicates a maximum power output of 50



watts. It is capable of measuring that power accurately, determining the characteristic impedance or effect of load variation on the system, and other applications involving the measurement of power and impedance.

With an impedance adjustable over a range of 40 steps from 2.5 ohms to 20,000 ohms, the instrument will measure 50 watts in steps of .1 milliwatt. It is also calibrated to measure decibels from −10 db to +47 db.

REGULATED POWER SUPPLY

Kepco Laboratories, Inc., 149-14 41st Avenue, Flushing 55, New York, has released a new standard voltage-regulated power supply, the Model 3100.

The new unit features a low voltage regulated power supply with excellent regulation, high stability, low ripple content, and low output impedance.

The d.c. output voltage is continuously variable from 0-3 volts and delivers from 0-100 ma. In the range 0-3 volts the output voltage variation is less than 5 millivolts for both line fluctuations from 105-125 volts and load variations from 0-100 ma.

The supply is designed for relay rack mounting or bench use. It is 19" wide, 7" high, and 11" deep.

MINIATURE RESISTORS

Dale Products, Inc. of Columbus, Nebraska, has announced the availability of a new line of miniature power resistors in two, five, and ten watt sizes.

These "Dalohm" resistors offer completely welded construction from terminal to terminal for trouble-free performance. A special silicone material seals the resistance element, making it impervious to moisture.

Standard tolerance is one per-cent but tolerances as high as .05 per-cent can be furnished if required. The temperature coefficient of these units is practically flat. The resistance shift is less than .00002 per-cent per degree C.

New illustrated price sheets are available on request. —30—

International Short-wave

(*Continued from page* 114)

years only the 1330 period has been reported as "heard" and this on (only) 17.840. (Ferguson, N. C.; Saylor, Va., others)

Israel—Tel Aviv, 6.830, heard with weak level 0035; music. (Kary, Pa.) Tel Aviv's "claimed" 9.000 channel was recently *measured* 9.0075V; noted 1625 in *English;* previous measurements were 9.0096 and 9.0125. (Oskay, N. J.)

Italy—Rome, 15.315, noted with Italian news and musical program 0700; on 21.500 with *English* news and program details 0515. (Sanderson, Australia) Heard 0545 signing on for Far East on 11.91, 17.800, and 15.400; started with news; music 0600. (Pearce, England) Rome noted on 3.910 with music 1628; good signal in Britain. (O'Sullivan) Heard on 7.110 with Arabic to about 1610, then in Italian; news in Arabic 1545-1600. (Kary, Pa.)

Jamaica—Radio Jamaica, 3.360, still noted signing off 2300A with "God Save the Queen"; fair level in Calif. (Baker) Noted around 2000 with local programs and commercials. (Van Gilder, Mass.) The 4.950 outlet usually is a good signal in USA with news 0730. (Tschopp, Texas; others)

Japan—AFRS, Tokyo, noted on 4.860 at 0730-0830 and later; identifies on half-hour; local time is given after identification. (Tschopp, Texas) NHK's JK12, 9.655, noted 1740 in Japanese; time pips and "NHK" identification at 1800. (Pearce, England)

Kenya—When this was compiled, the Forces Broadcasting Service, East African Command, McKinnon Road Depot, was being heard on 7.265A relaying the BBC news at 2300; has recordings of popular music from 2315A; weak to fair level with QRM from VOA, Tangier Relay Base, on 7.270. (Stark, Texas; Bellington, N. Y., others) Usually identifies twice between end of BBC news at 2315A and start of recorded session. Ridgeway, South Africa, lists this one heard 2200-2400.

Nairobi, 4.855, noted with recordings 1445; closed 1458 with "God Save the Queen." (Pearce, England)

Lebanon—Beirut verified with QSL card; gave frequencies as 836 kc. and 8.036 at 0000-0115; 0515-0800; 1000-1600; *English* for 1000-1100; French 1200-1515. (Oskay, N. J.) Noted by Pearce, England, opening *English* session 1000.

Liberia—ELBC, Monrovia, appears to be on approximately 6.027 now (listed 6.025); noted as early as 1700 to closing with *English* announcement at 1845; has had QRM from around 1815 when PCJ puts carrier on the air slightly lower. (Kary, Pa.)

Luxembourg—Radio Luxembourg is scheduled daily 0600-0830 on 15.350; 1300-1900 on 6.090. (Radio Australia)

Madagascar—Radio Tananarive is now using three outlets for its French sessions—9.515, 6.17, and 3.320 (*new*). (*WRH Bulletin*) Heard on 9.515 at

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	Used	New
BC-453, with tubes	$19.95	
less tubes	14.95	
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BC-455, 6-9 mc receiver, with tubes	9.95	$14.95
less tubes	7.95	
BC-457, 4-5.3 mc transmitter, less tubes	5.95	
BC-458, less tubes	5.95	
BC-459, less tubes	12.95	
T-23 ARC 5, 100-156 mc unit		49.50
BC-494, 2 position Rec. Control Box		1.95
MC-215 Mechanical Drive Shaft, per length		2.45
BC-450 3 Receiver Remote Control		2.95
BC-451 Transmitter Control Box	.59	1.50
BC-442 Antenna Relay, complete		3.95
3 Receiver Rack	1.95	

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I 82 F Five Inch 360 degree compass indicator and Selsyn receiver		6.95
A-81-2 Transmitters Selsyn for 182 indicator (both 182F & Trans. Selsyn for $11.00)		4.95
PE-101 Dynamotor		2.75
Model 507, Thermal-converter Weston Type D, range 12 amp.		.59
BC-1023 Marker Beacon Receiver, complete with tubes, shock mount and instruction manual		9.95
RC42, kit of plugs, insulators, etc. for BC-1023, new		1.75
BC-924 27-38 MC. FM Transmitter, complete with tubes	19.95	
BC-684 27-38 MC. FM Transmitter, less dynamotor	19.95	
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BC 1206 Receiver, new		7.95
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BC-709, battery operated, lt. wt., inter-phone amplifier, complete with tube, shock mount and manual, brand new **ea.**		$3.95
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PE 120 Vibrator Power Supply for BC 620-659, used, less vibrator	4.95	
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CW 49805 High Impedance headset complete with leather headband and rubber cushions. Used	98c
HS-38, Microphone	new $4.95
TS 10 sound powered HAND SET	new $9.95 ea. used $5.95 ea.
HS-37	new $2.29
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See page 43—December "Radio News" **$5.95 ea.**

CONDENSERS 19c each 6 for $1.00
1 mfd.—800 VDC; 1 mfd.—400 VDC; .1 mfd.—1200 VDC; 1-2-4 mfd.—400 VDC; 1 mfd.—1200 VDC; .1-.1—2000 VDC
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1120 with news in French by man and woman, interspersed with short pieces of music; call 1130, then popular and light musical items; still audible 1340 with drama in French. (Pearce, England)

Malaya—Radio Malaya, 7.200, noted with news and musical program 0615. (Sanderson, Australia) Kuala Lumpur, 6.025, heard closing 1030 after dance music session. (Ridgeway, South Africa)

BFEBS, 9.69, Singapore, closes 1000; BBC news is relayed 1100 over the 11.955 and 15.300 outlets. (Ridgeway, South Africa) Noted on 7.120 at 1041; fine level in Calif. (Winch)

Mexico—XESC, 15.205A, strong afternoons (*EST*); XEXE, 11.900, at good volume 0900 and around 1800 announcing "La Voz de Mexico"; XEHH, 11.880, very strong mornings, also good afternoons and evenings, often causes interference to LRS, Argentina, same channel. (Niblack, Ind.)

Monaco—Radio Monte Carlo, 9.785, noted 1100-1200, mostly music with French announcements; good signal for the time of day. (Baker, Calif.) Noted Fridays on 6.035 ending "Back to the Bible" (*English*) at 1805; left air 1810. (Catch, England; others)

Mozambique—The 19 m. outlet of Lourenco Marques was noted recently on 15.265A with a surprisingly good, steady signal, comparatively free from interference, at 1200 when had news in Portuguese followed by commercial advertisements and what seemed to be stock market quotations to around 1215. (Kary, Pa.) Sent QSL card confirming CR7BG, 15.270, 10 kw. At last check seemed close 15.29. CR7BU, 4.925V, noted 1450 with popular music and (*English*) commercials; CR7BV, 4.82V, heard 1450 with light music; off with "A Portuguesa" at 1500. (Pearce, England)

CR7BU, 4.9262, noted 1650 with American recordings and *English* announcements; signed off 1702; announced as parallel in the 30-meter band; woman made final announcement in Portuguese before station left the air. (Oskay, N. J.) When this was compiled, Lourenco Marques' 31-m. outlet used for *English* sessions was being alternated between approximately 9.740 and 9.770; when noted afternoons (*EST*) to 1600A sign-off on 9.770A was in clear with fine level; when on 9.740A was weak and almost buried by OTC2, Belgian Congo. (Boice, Conn.; Hord, Ind.; others)

The 31-m. outlet used for Portuguese programs from 0000 is still wandering around; more recently was heard on 9.820A at strong level and with no QRM. (Bellington, N. Y.)

New Caledonia—Radio Noumea, 6.035, noted from 0200 sign-on (with "La Marseillaise") to 0245 with music; good strength in Calif. (Baker) Usually has QRM from VOA from around 0230. (Oestreich, Washington State)

New Zealand—ZL4, 9.540, noted with weak level 0530 with news to 0545 sign-off; at end of newscast gave preview of next day's programs. (Kary, Pa.)

Nicaragua—A Spanish-speaking station noted on 6.055 at 1920 is believed to be YNOW which is no longer heard on 6.833. Nicaraguan stations are in the process of *moving* to *new* channels. (Oskay, N. J.) Tschopp, Texas, also reports YNOW on 6.055, noted 2345-2400 when signed off with march.

The Latin American heard on 6.47A evenings is *Radio Mundial;* heard so announced in Spanish at 2200 recently. (Bellington, N. Y.)

Northern Rhodesia—GDX-aren, Sweden, lists ZQP, 7.220, to 1230 sign-off.

Norway—LLP, 21.670, heard with Norwegian news and music 0600; LKV, 15.170, heard with *English* and Norwegian program 0600. (Sanderson, Australia)

Pakistan—Radio Pakistan, 11.885, noted with Arabic news and music 2045; on 15.335 with news for local listeners 2245, and on same channel with news for native listeners at 0630. (Sanderson, Australia) Sent QSL card by airmail; confirmed Lahore (heard on 4.805) relaying Karachi 11.674; Dacca, 15.620, relaying Karachi on 7.0966; Karachi, 11.674 and 9.484. Schedule for news in *English* was given as 2130-2145 on 7.0966, 15.335; 0200-0210 on 15.620; 0330-0340 on 9.645, 15.620; 0730-0740 on 7.0966 and 15.620; 1015-1030 on 6.235 and 11.674; and General Overseas Service (*English* at slow speed) at 1210-1230 on 6.235, 9.484. (Pearce, England) News at 2130 heard on 7.096A. (Lane, Wyo.)

Panama—HO50 is back on 5.9955; noted 0715 with music. (Oskay, N. J.) The Dawn Bible Students Association, East Rutherford, N. J., lists a contract for *English* Bible Study broadcasts with station HP6J, Panama, on 9.790 at 1815 on Sundays, says Oskay, N. J. *Heard?*

Paraguay—ZPA1, 6.275, Asuncion, fair at 1932-2000 and later. (Lane, Wyo.)

Peru—OAX4R, *Radio Nacional del Peru*, logged on 15.150A with fair to good signal 0345 in Spanish. (Saylor, Va.) *Radio Nacional del Peru*, 5.8864, heard with fine level mornings; noted signing on 0555 with series of trumpet melodies, then march selection 0600. (Oskay, N. J.) Recently found parallel on 5.8864 and 9.560A around 2317 with Latin American music. (Bellington, N. Y.) OAX4, 15.105, *Radio El Sol*, Lima, noted with *English* program 2200-2330. (Ferguson, N. C.)

Philippines—DZH9, 11.855, Manila, heard irregularly after 0100, fair signal in Calif. (Balbi) This outlet noted in Australia 0500 with news; and on 15.300 at 2200. (Sanderson) Lane, Wyoming, reports the 25-m. outlet is actually 11.854, noted 1020-1200 sign-off.

The short-wave outlet of "Voice of Davao" which was reported off the air some time ago is still heard by Wada, Japan, on its old channel of 7.280. (*WRH Bulletin*)

Poland—Warsaw noted on 6.115 with *English* for North America at 2315 and 0030. (Fried, Mich.)

Portugal—"Aqui Lisboa Emissora Catolica Portuguesa," or "Radio Renascenca," logged on 6.154 with gong and call 1732; orchestral selections; at 1800 had call, then classical music; another day at 1800 had sacred music by choir. (Pearce, England)

Lisbon, 15.130, noted from tuning 1105 with powerful signal; went off suddenly at 1125. (Bishop, Ohio) Heard on 11.995, with 11.960A in parallel, at 1430. (Kary, Pa.) *Radio Free Europe*, 9.605, noted 1600 with Hungarian session. (Oskay, N. J.)

Portuguese Guinea—Bissau, 5.838A, noted with news of Portugal at 1720, followed by news of the world (also in Portuguese) to 1730; signed off 1800 with "A Portuguesa." (Kary, Pa.)

Roumania—*Radio Bucharest* noted with news 1400 on 9.252 at fair level; good level then on 6.210. (Pearce, England) Ridgeway, South Africa, reports Bucharest was heard recently on 7.250 as early as 1130; *English* at 1530.

Sao Tome—*Radio Clube de Sao Tome*, 4.8075, CR5SC, noted 1450 tune-in; gong, call at 1500, followed by varied recordings to 1600 when closed with "A Portuguesa." (Pearce, England)

Saudi-Arabia — Djeddah, 5.987A, noted recently signing on 2330 in Arabic. (Kary, Pa.) Sign-on varies. Noted by Lane, Wyo., on 11.950 at 1200-1300.

South Africa—SABC, 5.892A, Cape Town, still noted signing on weekdays 2345 with setting-up exercises. Reported by Kary, Pa., at 0000 with news in Afrikaans. Pearce, England, reports "SABC Calling Africa" on 11.937 in *English* 1200; announced would run to 1500 closedown. Asked for reports to SABC, Johannesburg; at 1200 had news, weather, sports.

Southern Rhodesia — Salisbury, 7.285A, noted 1030-1045 with children's program (*English*) recently; good level in Calif. (Baker) Noted on Saturdays as early as 1030; at times with relays from BBC; usually fades out between 1130-1230. (Rosenauer, Calif.) Noted on 3.320 when tuned 1445, had dance music; closed 1500 with "God Save the Queen." (Pearce, England)

Spain—Malaga, 7.022 has French on Wednesdays 1600-1620. (Radio Sweden) This one noted in England closing 1800 with two clock chimes, Spanish announcement, and Spanish National Anthem. (Catch) FET-1, 7.008V, *measured* at 1550 when had music; previous measurement was 7.0038. (Oskay, N. J.) Madrid, 9.368A, noted 1815 with *English* for North America; fair level in Chicago. (Faivre) *Radio S.E.U.*, EDV10, now is on about 7.088, heard to after 1800. (Pearce, England)

Surinam—According to a verification from the station, Paramaribo uses 5.757 at 0810-1040, 1540-2040, and Sundays 0640-1140, 1440-2100; also on 15.405 from 1710. (Radio Sweden) The 15.405 outlet noted on a Sunday 1000-1030 sign-off carrying a religious program in Dutch and *English*. (Kary, Pa.)

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Sweden — Radio Sweden, 11.880, noted at good level in North America in *English* 0700-0715, then in Swedish to 0745 closedown. (Guentzler, Ohio; others) SBP, 11.705, noted with church services, then musical program 0530. (Sanderson, Australia) Noted parallel at 1945 in *English* on 6.065 and 6.095. (Oskay, N. J.) And parallel on 9.535 and 9.620 with *English* 2300-2315. (Bellington, N. Y.) Noted by Mast., N. Y., on 6.065 at good level around 1430.

Switzerland — HEI3, 7.210, Berne, noted with fair signal in North American beam around 2100 through much CWQRM. (Lund, Iowa)

Taiwan—BEC32, 9.780, has clear signal in Australia 0530 with Chinese session. BEC26, 10.080A, good signal with Chinese news and music 0630; BEC36, 7.334, noted with National Anthem and Chinese news and music 0700. (Sanderson, Australia) Taipeh, 7.133, heard at good level recently 0650 to as late as 0815; announced calls of BED2, BED7, and BED6; mostly in Chinese dialects. (Kary, Pa.) *"The Voice of Free China,"* 11.800, Taipeh, noted with *English* 1420-1440. (*GDX-aren,* Sweden)

Tangiers — Radio Africa, 7.130A, noted 1310-1435 with dance music; announcements by woman in Spanish and by man in French. (Rodger, Scotland) Noted by Pearce, England, at 1025.

Pan-American Radio, 7.300, heard 1730 with popular recordings; announcements in French by woman; at 1801 had sign-off announcements in French, Spanish, *English.* (Catch, England)

Thailand — Bangkok, 15.910, noted 0630 with announcement in *English,* then news in Thai; on 6.240 with Western music and news in Thai 0645. (Sanderson, Australia)

Trans-Jordan — Hashemite-Jordan Broadcasting Station, Jerusalem, broadcasts on 44.3 and 42.5 meters at 0000-0100 in Arabic; 0600-0630 in *English;* 0630-0730 in Arabic; 0930-1030 in *English,* and 1030-1430 in Arabic, according to verification. Ramallah is listed on 7.110. (Radio Sweden)

Trinidad—Radio Trinidad's new outlet on approximately 3.270 normally signs off 2200 but on some occasions runs longer with special broadcasts. (Golden, Mass., others) Some weeks ago carried relay of cricket games from *Radio Australia* until around 0230. Relays BBC news 2100. Mudryj, Mich., notes *Radio Trinidad* on 9.625 at 0545 with news, according to the United 49'ers Radio Society.

Turkey—TAP, 9.465, noted with news 1615; TAV, 17.830, with news and music 0730. (Sanderson, Australia) TAT, 9.515, still noted at good level 1815-1900 with *English* session for North America. (Hord, Ind.) TAQ, 15.195, noted at good level 1030-1045 in Persian. (Ridgeway, South Africa)

Uruguay — Montevideo, 11.835, excellent around 1830; all-Spanish programs. (Niblack, Ind.)

USI (Indonesia) — Radio Andir, 11.940, noted with musical program,

Dutch announcements 0600. (Sanderson, Australia) Current schedules of Djakarta include to Australia-New Zealand 0600-0700 over YDC, 15.150; to Malaya 0600-0700, YDB2, 4.910; to India 0930-1030, YDC, 15.150; to West Coast USA, YDE, 11.770 at 0930-1030; to Malaya 0930-1030, YDB2, 4.910; to Europe 1400-1500, YDF7, 11.770; to New Zealand 1400-1500, YDC, 15.150; Dutch program to Holland 1300-1400, YDF7, 11.770, and YDC, 15.150. (ISWC, London) YDE, 11.77, and YDB3, 7.27, noted 0600 with *English* talk. (Balbi, Calif.)

USSR—When this was compiled, *Radio Moscow* was noted with good signal on 11.825 with the *English* program for North America 0800-0830; several other channels parallel.

A Soviet outlet has been logged on *measured* 4.3956 at 0640 with oriental-type music and man announcer in foreign language; bad CWQRM; identified with Moscow chimes 0630. Moscow, 4.947, noted 1635 with news in progress; CWQRM. (Oskay, N. J.) *Radio Tashkent*, 6.825, noted signing on in *English* for India-Pakistan at 1115; had news, commentary; at 1130 announced *English* sessions are 1000 and 1115 daily in this service. (Pearce, England)

Vatican—HVJ, 5.9674, noted 1525 with man in European language; identified 1545 with bells of St. Peter's; Hungarian program followed at 1545. (Oskay, N. J.) Noted on 9.646 with news 1000; in Polish 1015 when was jammed. (Lane, Wyo.)

Venezuela—YVKB, 4.890, Caracas, noted 2230-2300; YVKF, 4.880, tuned 1745 when had news in *English;* identified as "Ondas Populares" at 1800. YVLK, 4.972, Caracas, heard 1915-1935 with all-Spanish program. (Tschopp, Texas) YVKO, 6.170, noted in Spanish 1903. (Bellington, N. Y.)

Yugoslavia—Radio Yugoslavia, Belgrade, is noted on 6.100 to 1800. (Bellington, N. Y.) Sent schedule for this channel as 2330-0100, 0845-1200, 1400-1800; *English* at 1145-1200, 1400-1415; French 1415-1430, 1700-1715. (Pearce, England)

* * *

Press Time Flashes

According to a letter from the Director, Emisora de Radiodifusora, Spanish Guinea, some weeks ago Santa Isabel, 7.200, was to have increased its power to 750 watts; schedule was to be 0130-0230, 0700-0900, 1300-1500 daily; all-Spanish except 1300-1330 when was to carry Portuguese for Sao Tome, Principe, and Angola. (Oskay, N. J.) *Has not yet been reported as heard.*

The station engineer of 2AP, 3.410, 6.030, Apia, Western Samoa, has notified Fox, New Zealand, that (proposed) tests will *not* take place now. (Radio Australia) De Leon, Mexico, reports TGNA, Guatemala, on *announced* 5.942 with fair level 2000-0000; Tegucigalpa, Honduras, on *announced* 6.075 with good level 1930-2030.

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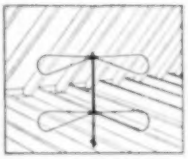

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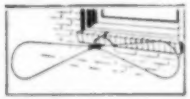

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380	411	484	512	646	669	6522	7155
381	412	485	514	647	670	6547	7220
383	413	487	515	648	672	6610	7254
384	414	488	516	650	674	7350	7280
385	415	490	518	651	675	7400	7282
386	416	491	519	652	676	7500	7290
387	419	492	520	655	677	7610	7300
388	419	493	522	657	679	7930	7305
389	420	494	525	659	680		7320
391	422	495	526	661			7360
392	423	496	530				7390
393	424	497	531				7415
394	425	498	533				7435
395	426	503	537				
396	427	504	538				
397	429						
398	431						
401	433						
402	434						
403	435						

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5073	7740	7973	5305	5940	6373	6606	7573
5105	7773	8273	5677	5940	6406	6625	7606
5175	7806	5206	5706	5873	6440	6640	7640
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is audible in Sweden 0600 with program in German; sent nice QSL card; power is only 0.3 kw. (Lundin) OTC, 9.767, Leopoldville, Belgian Congo, announces *English* for North America now is at 2100-2315. (Stark, Texas)

4VEH, Haiti, informs Hord, Indiana, that it is out of QSL cards and doesn't know when will have more.

Radio Jornal do Commercio, Recife, Brazil, was noted recently (Sunday) around 0630 on 11.825; may be using that channel during the 0355-1100 session. ZPA5, Encarnacion, Paraguay, heard at strong level 1010 and again 1520 on 11.945. (Serrano, Brazil)

"Date With Baghdad" is the title of a series of *English* programs especially arranged by the Iraqi Broadcasting Station for listeners in Europe daily 1413-1500 on 11.724; includes news, cultural and spiritual aspects of life in Iraq; also classical and popular music; opens 1413 with song of the Bulbul (nightingale of Iraq). (*WRH Bulletin*)

Radio Mundial, 6.465, Nicaragua, is back on the air; is listed YNZZ, Managua, at 400 watts; noted to past 2300 and on by 0700. (Stark, Texas) HVJ, 15.095, Vatican, noted with fair level in French 0930-0945, then in German to 1000. (Kary, Pa.) HI2A, 9.68, Dominican Republic, heard with strong signal around 1750; news in Spanish 1755-1800 when announced "La Voz de Receleccion." Lisbon was recently logged at 1515 on 11.96, 11.995, and 12.025; badly QRM'd on latter channel; heard 1635 parallel on 9.74, 11.96. (Bellington, N. Y.)

OXI, Godthaab, Greenland, sent QSL card giving current frequency as 7.094 at 1630-1845. (Pearce, England) Noted on approximately this channel signing off 1900 with the Danish National Anthem; suffers badly from CWQRM. (Robbins, Ind.)

When this was compiled, *Radio Free Europe* was being widely heard on many channels; often heard around 1730 parallel on 7.105, 7.285, 7.300, and 9.605, and with a separate program on 7.190A. At various times lately has been found on 5.97, 5.985, 6.02, 6.095, 7.105, 7.14, 7.190A, 7.285, 7.300, and 9.605. Most of *Radio Free Europe's* transmitters are listed in Germany, but at least the 9.605 channel is a relay from Lisbon, Portugal. (Bellington, N. Y.; others)

A *WRH Bulletin* says the VOA program in Korean at 0630-0700 and 1730-1800 is relayed in Korea by Pusan on 2.510 and 7.935 and by Taegu on 4.777; that a VOA program at 0845-0900 is repeated by these stations at 2130-2145, and that a roving transmitter ship relays all VOA programs in Korean.

A flash from *Radio Sweden* says *Radio Africa*, Tangiers, now on 7.125A, will soon radiate on 6.020 with 25 kw.

Patterson, Ga., says he recently heard *Radio Algerie* at 1740-1800 sign-off on approximately 7.210; man and woman announcers; left air after playing "La Marseillaise;" had bad CWQRM. Stark, Texas, reports *Radio Nacional del Peru*, 9.562A, coming through before 1900 and heard usually to at least 2300; at times has bad heterodyne.

Galei-Zahal, 4XB44, Israel Forces Broadcasting Service, Army P.O.162, Israel, sent QSL card listing 6.725 as frequency; schedule of 1130-1500. (Pearce, England)

O'Sullivan, England, reports Madrid, Spain, heard on 4.470 at 1650 with tangos, good level. Pearce, England, recently heard a station on 9.610 at 1035 with "Bringing Christ to the Nations" (*English*) which he believes is *Radio Goa*, Pt. India; unintelligible after 1058 due to sign-on of a station on the high-frequency side (VOA Relay, Tangiers) and one on the lower side (*Radio Free Europe's* relay from Portugal). Heard another day 1010 in Portuguese; at 1115 in native dialect. He reports *Radio Pakistan*, 15.620, Dacca, with *English* 0200-0210; Pakistan with news on 5.990 parallel 11.674 at 1015-1030; news at dictation speed 1210-1230 on 9.484, 6.235; also at 1430-1515 on 7.010 and 6.235 with test broadcast to Turkey, then to 1600 to the

Among those attending the first postwar meeting of the World Friendship Society of Radio Amateurs in London were: Albert Eagle, WFSRA member; a representative of the Mullard Organisation; A. H. Bird, G6AQ, the general secretary of WFSRA; and John Beavan, G3GBL, secretary of the society's "Bedfast Club."

United Kingdom; had varied Western and Pakistani recordings; announced in *English* about every 15 minutes. Pearce reports FET-1, *Radio Falange de Vallodolid*, Spain, on 7.006 at 1500 signing on with long selection of Spanish music; call by woman, "Viva Franco! Arriba Espana!" Then news in Spanish.

Radio Juventud, Cadiz, Spain, noted on 7.200 to 1800 closedown; sent nice QSL card. (Robbins, Ind.)

Current schedules for newscasts from AIR's Home News Service are 2130-2145 on 3.250, 5.990, 7.170, 9.630, 11.850, 15.290 (Delhi), 6.150 (Bombay), 6.010, 7.210 (Calcutta), 4.920, 6.085 (Madras), and 6.065 (Mysore); at 0300-0310 on 7.290, 9.630, 15.290, 17.740, 17.760, 21.700 (Delhi), 9.550 (Bombay), 7.210 (Calcutta), 7.260 (Madras), and 6.065 (Mysore); at 0730-0740 on 7.170, 9.590, 15.380, 17.760 (Delhi), 6.150 (Bombay), 6.010 (Calcutta), 6.085 (Madras), and 6.065 (Mysore); at 1030-1045 on 3.250, 3.435, 4.940, 5.960, 9.590, 11.940 (Delhi), 4.840 (Bombay), 3.350 (Calcutta), 4.920, 6.085 (Madras), and 6.065 (Mysore). (*WRH Bulletin*)

Allocated channels for stations in Pakistan include Dacca (7.5 kw.), 3.460, 4.807, 5.035, 6.120, 7.140, 7.263, 7.655, 7.668, 9.614, 11.890, 15.270, 15.335, 17.835. Karachi (two transmitters of 50 kw. each), 3.450, 4.935, 5.980, 5.990, 6.075, 6.235, 7.010, 7.096, 7.263, 9.484, 9.645, 9.755, 11.570, 11.580, 11.650, 11.674, 11.726, 11.770, 11.810, 11.845, 11.885, 11.914, 15.270, 15.335, 15.620, 17.770, 17.835. Lahore (0.3 kw., to be increased to 10 kw.), 3.355, 4.785, 6.075, 6.138, 7.270, 7.284, 11.800, 11.840. (*WRH Bulletin*)

Radio Sweden's weekly DX session are being aired in the Home Service on 11.705 on Fridays at 1015 and on 6.065 at the end of the Home Service around 1730 (Fridays), and on 6.065 on Saturdays at the end of the "morning" transmission at 0215. At the time this was written, did not seem to be radiated in the Overseas Service over the new 100 kw. transmitters at Horby. Sweden's Home Service is broadcast throughout the "day" by one of the old 12 kw. transmitters at Motala on 7.270. The official schedule for the new 100 kw. transmitters in the *English* language periods of the International Service is to Eastern North America 1900-2000, 6.065; 0700-0615, 11.880. To Western North America 2300-2315, 9.535; 1600-1615, 9.535. To South America 1900-2000, 6.095; 0600-0615, 21.580; 1800-1815, 6.095. To Far East 0800-0815, 9.535; 1800-1815, 9.535. To South Asia 2300-2315, 9.620; 0900-0915, 9.535; 0945-1030, 9.535. To Middle East 2200-2215, 9.535; 1200-1215, 9.535. To Africa 0000-0030, 9.535; 1300-1315, 9.535. In most cases, Swedish is used for 30 minutes at the end of these *English* periods. The European Service is on 6.095 in Swedish 1400-1430; German 1430-1500; *English* 1500-1530, and French 1530-1545. The Swedish Home Service is relayed 0000-0400 on 6.065; 0400-1200, 11.705; 1200-2245, 6.065. Wants

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1AB3	.59	5V4G	.54	6BQ6GT	.59	6U8	.89	19BG6G	.59
1B3	.49	5Y3GT	.33	6C4	.37	6V6GT	.39	19T8	.79
1B3	.59	5Y3G	.33	6C5GT	.39	6W6GT	.44	25BQ6GT	.62
1B7GT	.59	5Y4G	.33	6C86	.44	6W6GT	.44	25L6GT	.39
1C5GT	.43	5Z3	.59	6CD6G	1.11	6X4	.37	25Z5	.40
1G6	.55	6A3	.59	6E5	.48	6X5GT	.37	25Z6GT	.37
1N4	.46	6AB4	.44	6F5GT	.39	6T6G	.48	32L7	.85
1N5GT	.40	6AC7	.59	6F6G	.39	7A6	.43	33GS	.40
1L4	.46	6AG5	.43	6F6GT	.37	7X6	.39	35C5	.39
1L6	.43	6AJ5	.90	6G6G	.53	7Z4	.37	35L6GT	.41
1LC5	.51	6AK5	.75	6H6GT	.41	12AB6T	.46	35W4	.37
1LC6	.48	6AL5	.38	6J5GT	.37	12AL5	.37	35Z3GT	.37
1LN5	.51	6AQ5	.39	6J6	.53	12AT6	.37	36	.49
1N3	.46	6AQ6	.37	6J7G	.43	12AU7	.56	41	.43
1P5	.37	6AR5	.37	6J8G	.63	12AU6	.43	42	.43
1R5	.43	6AT6	.37	6K6GT	.37	12AU7	.43	43	.55
1S5	.39	6AU6	.38	6K7G	.44	12AV6	.39	45	.55
1T4	.43	6AV6	.37	6K7GT	.44	12AV7	.59	50B5	.39
1T5	.53	6B4G	.64	6L6G	.64	12AX6	.48	50C5	.39
1U4	.43	6B5	.64	6L6GA	.64	12AX7	.48	50C6	.39
1U5	.39	6BA6	.39	6N4	.48	12BA6	.46	50L6GT	.41
2A3	.59	6BC5	.44	6S8	.53	12BA7	.46	50X6	.53
2A4	.43	6BD5GT	.59	6SA7GT	.43	12BE6	.39	50Y7	.50
3E5	.46	6BE6	.39	6SD7GT	.41	12K7GT	.46	70L7GT	1.09
3Q4	.48	6BF5	.41	6SH7GT	.41	12Q7G	.39	76	.44
3Q5GT	.49	6BF6	.37	6SJ7GT	.41	12SA7GT	.44	80	.35
3S4	.46	6BQ6G	.94	6SK7GT	.41	12SK7GT	.48	117L7	.89
3V4	.47	6BN6	.46	6SL7GT	.48	12SL7GT	.47	117Z3	.37
5AX4	.37	6BJ6	.39	6SN7GT	.53	12SN7GT	.53	807	.99
				6SQ7GT	.37	12SQ7	.44	1274	.99
				6SR7	.37	12SR7	.49	1276	.99

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Clare Type C	600	DPDT	2.25
Clare Type C	4000	DPDT	2.25
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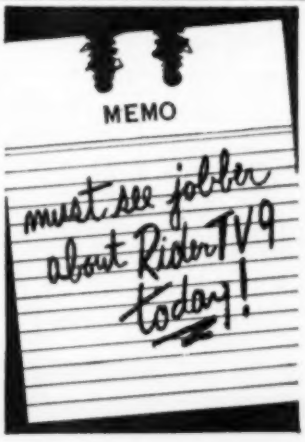

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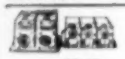
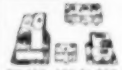


SCR-27N COMMAND and ARC-5 Equipment



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C-438 Modulator	3.95	6.95
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PHONES: WO 4-0827 and WO 4-0828

reports to Radio Sweden, Stockholm 7, Sweden.

The International Red Cross, Geneva, Switzerland, has been testing recently at various hours over 7.210. Will make further tests during the year; wants reception reports.

Paris is using 7.103 for Finnish programs 1215. (Radio Sweden)

AIR, 5.990, noted with European Service (*English*) daily 1400-1515. (Hansson, Sweden) *Radio Alerta*, Valencia, Spain, is now audible on 7.500 to 1800) sign-off. (Radio Sweden)

Damascus, Syria, recently sent this schedule—on 11.915, 20 kw., to Western Europe, 1530-1630 French, 1630-1730 French; 17.865 20 kw., to India-Pakistan, 0945-1045 in *English* and Arabic; 7.145, 20 kw., 0200-0930 Arabic, *English*, and French; 6.165, 20 kw., 2330-0200, 0630-0800, 1000-1700, (Kelting, N. Y.) The 7.145 outlet should have *English* 0500-0600. (Leinbach, N. Y.)

YNWW, *Radio Sport*, 7.849, Nicaragua, heard 2045-2300 sign-off. (Krejny, Ohio)

The monthly DX sessions from Berne, Switzerland, are scheduled for the *first* Tuesday and Wednesday of each month as follows—Tuesday—To United Kingdom and Ireland, 1405, 9.665, 6.055; to North America 2050 and 2235 on 6.165, 7.210, 9.535, 9.665, 11.865. Wednesday—To Eastern Australia and New Zealand 0235, 11.865; to Western Australia and Far East 0420, 15.305, 17.784; to Southeast Asia and Japan 0805 on 11.865, 15.305, 17.784; to India and Pakistan 1005, 11.865, 9.665; to South Africa, 1005, 15.305; Middle East 1205, 11.865, 9.665.

* * *

Acknowledgement

Thanks for the fine reports, fellows! They will be welcomed from anyone, anywhere in the world—to Kenneth R. Boord, 948 Stewartstown Road, Morgantown, West Virginia, U.S.A. . KRB.

LIGHTWEIGHT CORD FOR PHONES

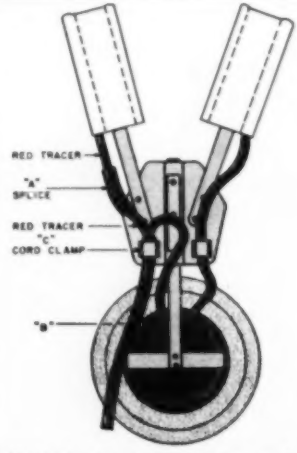
By ARTHUR TRAUFFER

MANY thousands of the war-surplus earphones, shown in the photograph, have been sold, but the writer never met anybody that likes the heavy cable and split-connector that comes with it. Designed for rugged armed-forces use, the heavy stiff cable is a nuisance when these fine phones are used for test work, crystal sets, or any application where weak signals must be heard. Every little bump or jar on the cable is carried to the phone and sounds like somebody is hitting the phone with a hammer! And the writer has actually had a pair of these phones slide off a table by the sheer weight of the cable hanging over the edge!

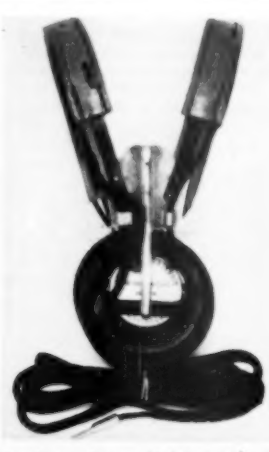
To do away with all this, you can easily replace the cable with a lightweight soft and flexible cord, as follows: Obtain a standard cord for a single earphone. These are from four to six feet long, have copper tinsel inner conductors, and pins on both ends, or pins on one end and spade-lugs on the other. Referring to the drawing, cut the old cord at "A," loosen the set-screw and pull out cord at "B," and pull the cable out of cable-clamp "C." Now pull the new cord through the clamp and connect the same as the old cable was connected. At point "A" you will have to make a twisted splice; wrap the splice with fine wire, and tape tightly. You cannot solder the splice without melting the copper tinsel conductor.

At point "B," break the two small prongs off of the spade-lug and insert the tip of the cord into the hole in the phone and tighten the set-screw. Now mash the cable-clamp with a pair of pliers to hold the new, smaller diameter cord securely. You will be pleased with the convenience of the new soft lightweight cord.

—30—



Method for changing the earphone cord.



Surplus earphones with lightweight cord.

Variable Resistances

(Continued from page 73)

and the response is flat. Experimental curves for this circuit are shown in Fig. 9. The control voltage can be introduced between ground and the grid of the control tube when dynamic action is desired. The characteristics of this circuit are seen to be similar to those of Fig. 8 except that the circuit of Fig. 7 offers the additional advantages of inverse feedback.

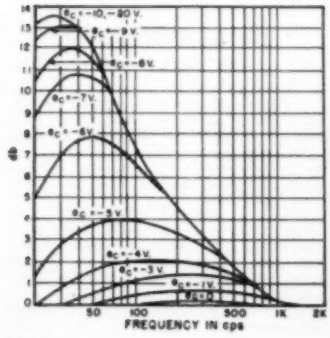
So far the writer has used resistance tubes only in circuits operating at low (audio) frequencies. Resistance tubes appear to offer no particular advantages when used in connection with high frequency amplifiers, particularly with those employing tuned circuits. It seems probable that the tube capacitances of the resistance tube would introduce undesirable effects in such applications. However, in low frequency circuits where little distortion can be tolerated the use of resistance tubes as attenuators is simple and effective.

The applications cited are by no means exhaustive but are described merely to indicate some of the possibilities. Technicians in fields other than audio will appreciate the application of resistance tubes to their own special problems.

Pentodes as Resistance Tubes. All circuits described herein have used triodes as the variable resistance elements. The question naturally arises: Why not use pentodes? Inspection of pentode characteristics shows that the plate resistance is very small at low values of grid and plate voltages. However, as the plate potential increases from very small values to medium values, the changes in plate resistance are rather abrupt. The consequent curvature of the grid voltage lines in this region makes it difficult to satisfy the second criterion mentioned earlier. Furthermore, the screen current is very high at low plate voltages and the screen dissipation is likely to be excessive. Also, the relative simplicity of triode circuits seems to dictate their use in all but very special applications.

—30—

Fig. 9.



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Assembled 8" speaker	Assembled 12" speaker	8" speaker kit	12" speaker kit
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All kits include:
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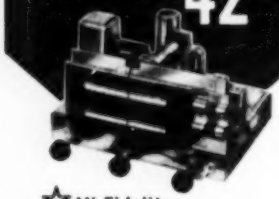

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For only $42.95 you get this $89.95 Pilot tuner complete with tubes, knobs, brown-and-bronze escutcheon, and built-in mounting brackets!

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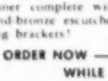

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RADIO SHACK
CORPORATION
167 Washington St., Boston 8, Mass.

Improved FM Sensitivity

By JAMES A. MITCHELL

A few simple tube changes help to boost the FM gain of a well-known high fidelity tuner unit.

THE *Meissner* AM-FM tuner, Model 9-1091A is a popular high fidelity tuner with good FM and excellent AM sensitivity. As used in my audio set-up it performed well but there were several FM stations 75 to 200 miles distant which did not come in with sufficient strength for good listening. This was largely due to the mountainous terrain in my East Tennessee location. Several good music programs were carried on some of them so I set out to increase my signal gain.

Consideration was given to yagi antennas and FM boosters but the need for antenna rotation and separate tuning discouraged those approaches. Several suggestions have appeared in print to increase the gain of TV sets by replacing the 6AG5's with higher transconductance tubes like the 6BC5. This approach offers a very convenient solution and was successfully tried.

The 9-1091A has a full Armstrong circuit with a tube line-up as follows: r.f. amplifier, 6AG5; oscillator, 6C4; converter, 6AG5; i.f. amplifiers, 3—6AG5's; limiters, 2—9001's; and detector, 6AL5. Thus there are five 6AG5's in the circuit. Higher gain replacements are the 6BC5 and the 6CB6. The 6BC5 has a higher transconductance than the 6AG5 and has identical pin connections. The 6CB6 has still higher tranconductance but a connection must be made from the No. 7 to the No. 2 pin, since the suppressor grid is not connected to the cathode internally in this tube as in the other two. The increase in transconductance is from 5000 for the 6AG5 to 6200 for the 6CB6 under identical circuit values. Thus it would seem that an increase in gain on the order of 20% might be obtained by substituting a 6CB6 for a 6AG5. Since there are five 6AG5's in series the total increase in gain by replacing them all with 6CB6's could be 1.2⁵ or 2.5.

The circuit diagram showed that a connection between the 7 and 2 pin already existed in the r.f. amplifier, so I slipped in a 6CB6. A slight readjustment of the input and r.f. amplifier alignment condensers was necessary for maximum gain. The interelectrode capacitances of these tubes is just enough different to require a slight adjustment. The meter showed the input to the limiters to be up 20%. I settled for putting a 6BC5 in the converter position so that I would not have to get into the tuning unit at all. The signal was now up nearly 40% and two of distant stations were limiting satisfactorily. The slight alignment adjustments could be made easily by watching the tuning eye.

After about a month of improved reception the urge to change the i.f. tubes possessed me and so I soldered short leads across the 2 and 7 pins and put the 6CB6's in place. Again it was thrown out of alignment and this time it took a little professional assistance with an oscillator to get it properly tuned. The gain was a little more than doubled by this change, however, and I was not only getting the original borderline stations with good quieting but several new ones appeared on the dial. The over-all increase in signal gain was estimated at 2 to 3 times. No tendency toward oscillation or instability was ever noted, although the gain of the already hot three-stage i.f. amplifiers was doubled. Background noise between stations was definitely increased but the limiting was so improved by the extra signal strength that critical listening is now enjoyable on many stations not previously picked up.

These changes have been incorporated in another *Meissner* of the same model in town with similar improvement in results. These tube substitutions are recommended if a two- to threefold increase in gain will improve FM reception and may as well be put into effect as tube failures occur.

—30—

ROCHESTER HAMFEST

THE Rochester Amateur Radio Association will hold its annual hamfest on Saturday, May 10th at the Elk's Club in Rochester, New York.

Technical talks are scheduled for the afternoon and a special program has been planned for the entertainment of the ladies. Dinner will be followed by entertainment and a talk.

For reservations write the Rochester Amateur Radio Association, P. O. Box 1388, Rochester 3, New York.

—30—

SPEAKER SHIM

By HARRY J. MILLER

CONSIDERABLE success in centering voice coils of small speakers is possible by using narrow strips, cut from snapshot negatives, as speaker shims.

These negative strips are thin enough to be practical and at the same time they have sufficient stiffness to permit easy insertion.

When a speaker, which has a gap larger than the thickness of the negative film, is to be re-centered, make the strip slightly wider and its springiness will compensate for the extra space. In this case, the width of each shim used, generally three, should be the same. —30—

Auditorium Amplifier

(Continued from page 68)

age, but additional filtering is supplied by the decoupling condensers mounted on the amplifier chassis. The *Chicago* PSC 200 transformer is rated at 385-0-385 volts at 200 milliamperes, but with the filter system as shown, voltage tests indicated that the full 400 volts of d.c. were available at the plates of the output tubes under full load. The power supply is entirely capable of supplying the requirements of this amplifier as indicated by the fact that after several hours of operation, the power transformer becomes only slightly warm. In fact, it is the coolest running unit with which the author has had experience.

The output transformer is the *Chicago* BO-9, connected to match a 3000 ohm plate-to-plate load to speaker and line. A jack is supplied for an 8 ohm speaker and a terminal strip is provided for the other output impedances. In order to further reduce the already low output impedance of the amplifier, inverse feedback is used from the plate of one of the output tubes to the plate of the 6SR7. Care must be taken to supply the feedback from the plate of the output tube which is in-phase with the plate of the 6SR7. This can be done by experiment, the out-of-phase tube connection resulting in a squeal or howl. The feedback voltage is delivered by a 100,000 ohm, ½ watt resistor connected directly between the two plates. No reactances are included so that no frequency discrimination will result because of this feedback.

The adjustments necessary for the correct operation of the amplifier are few and simple. The bias voltage must be adjusted by manipulating R_m until the voltage from grid to ground of each output tube measures —35. Then the plate current of each tube must be balanced by adjusting R_m. The best way to make this adjustment is to cut a milliammeter into each plate circuit and adjust R_m until each tube draws the same plate current. An alternate method is to place a voltmeter between the center tap of the primary of the output transformer and the plate of an output tube and to note the voltage. Then the voltage between this tap and the other plate should be noted. R_m must then be adjusted until these two voltages are the same. The author used a vacuum tube voltmeter in making these adjustments with excellent results.

The results obtained with the finished amplifier are very gratifying. Music and speech are reproduced with an exceptional clean-cut quality. Furthermore, extended listening tests brought about no listener fatigue—the quality sounded as good after several hours of listening as at first—a good test for any amplifier. Hum is practically non-existent at low listening levels, and is so far below the signal level at high volumes that it is impossible to discern it. —30—

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Oscillator requires 6.3 volts ac at 0.3 amp, and 250 volts dc at 2ma. Available from most amplifiers.

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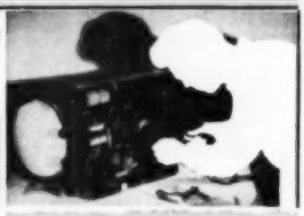

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.01	600	.20	.005	2500		.55	.003	5 KV	1.90
.02	600	.28	.002	2500		.45	.005	5 KV	2.50
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Interpreting TV Patterns

(*Continued from page 37*)

Outside interferences (excluding ghosts) when caused by radiation of electrical equipment will affect the picture only when such equipment is in operation. Time and effort are required to track down the appliance or equipment causing the interference. When the source has been determined it is possible to minimize the trouble by connecting a large condenser across the contacts, or by installing a booster at the receiver or detuning the i.f.'s.

Since the market for television receivers has almost reached the saturation point in metropolitan areas, TV distributors and dealers are now emphasizing sales in the suburbs and in nearby communities. Technicians will have to face the problem of poor reception in these fringe areas. The cause of pictures like those shown in Figs. 6, 7, and 8, is weak signal strength. Technicians have often modified receivers in order to increase gain and improve the over-all picture quality. These design changes are commendable only insofar as they produce the desired results. The best method is to increase the signal strength at the antenna terminals of the receiver. Since an antenna installation must often be a compromise because of the cost involved, receiver modifications such as substituting higher gain r.f. or i.f. tubes, removing or decreasing a.g.c. to the r.f. or i.f. stages, and realignment to decrease bandwidth and increase gain may be tried to obtain a more favorable picture. Before receiver modifications are attempted, the customer should be advised that while the changes will produce a better picture in the present location, if the receiver is moved to a stronger signal area or if at a later date the signal strength is increased, the receiver may not perform satisfactorily because of the modifications.

Fig. 6 illustrates the results of a faulty antenna installation and station interference in fringe reception areas. In local signal areas this condition may be due to lack of care when tuning in a station, generally tuning to the low frequency side of the signal- rather than the high frequency side. This may also be the result of overloading caused by a loss of a.g.c., gassy i.f. tubes, or a defective video amplifier stage. This condition may also be caused by a low-voltage filter condenser which produces 120-cycle hum.

The normal fringe reception test pattern of Fig. 7 is the pattern which may be expected on the screen of a receiver operating in a low signal area, a condition existing in fringe areas. In local signal areas this condition may be caused by a weak or dead r.f. tube in the tuner, i.f. tubes, or associated components.

Ghosts combined with a weak signal condition (Fig. 8) can generally be found in receivers which are operating on inside or built-in antennas in apartment buildings where an outside antenna is not permitted. This condition is also prevalent in cases where antennas are installed in valleys or are located between high buildings resulting in almost complete shielding of the antenna from the signal source. This condition may also be caused by a broken or shorted transmission line. Possible solutions to improve reception include installing an outside antenna where possible, increasing the height of the antenna, re-orienting or relocating the antenna, installing a booster, or performing receiver modifications to increase gain.

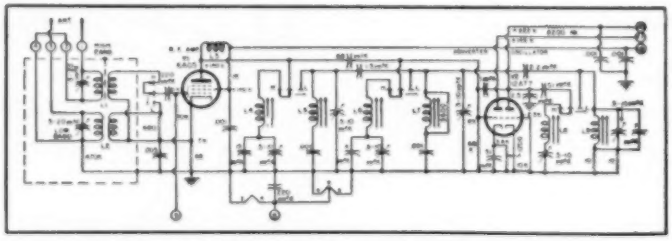
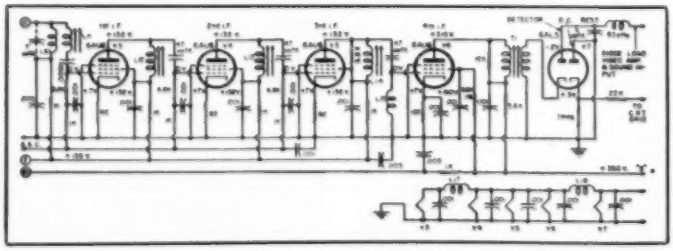


Fig. 11. Schematic of the tuner used in a current Raytheon television receiver.

Fig. 12. The video i.f. amplifier incorporated in a recent Raytheon video set.



A 60-cycle hum is generally due to a short or leakage between the cathode and filament in the i.f. or video amplifier tubes (See Fig. 9). The hum will be noticeable only when receiving a picture (raster will appear normal) if an i.f. tube is at fault or may be present at all times if a filament-to-cathode leakage exists in the video amplifier stage. This condition is also possible when one-half of the low voltage power transformer secondary is inoperative or when one-half of the low voltage rectifier is defective, causing a condition similar to that produced by a poorly filtered half-wave supply. Radiation from a 60-cycle sweep generator being operated near the receiver should not be overlooked as a possible source of the trouble. Substitution of i.f. or video amplifier tubes is a quick solution. One other method is to short the cathode of each defective tube to ground. Start with the higher gain tubes first and test only those tubes that are above ground with respect to 60 cycles. A short or leakage between cathode and filament will immediately show up.

Another common annoyance to the TV viewer is sound bars (Fig. 10). Sound bars may be caused by mistuning of the receiver, microphonic station camera equipment, a microphonic vertical oscillator tube, or microphonic a.g.c. controlled r.f. and i.f. tubes. A microphonic vertical oscillator will cause compression and expansion of the scanning lines which results in light and dark shadings. (A microphonic horizontal oscillator tube will produce a sideward displacement.) Brilliance modulations which show up as light and dark shadings are caused by microphonic r.f. or i.f. tubes which will not respond to vibration without signal. One simple method of determining which section of the receiver is at fault is to tune to an off channel and jar the cabinet. If the sound bars are no longer present an r.f. or i.f. tube is microphonic. If, however, the sound bars remain, the vertical oscillator tube is at fault. Once the troublesome section is found, tap the tubes until the microphonic tube is located. Replacement, obviously will cure the trouble.

In Part 2 of this series the video amplifier, a.g.c. system, sync, and vertical deflection circuits will be analyzed, using the picture tube as the source of information.

(To be continued)

NEW OFFICERS NAMED

THE Florida Association—R & TTG—has elected the following officers to serve one-year terms.

President Steven Petruff will have Shan Desjardines as his vice-president, Thomas M. Middleton as secretary, and A. Ed Stevens as treasurer. Board members include: John Gilbert, Samuel Kessler, C. E. Lawrence, John J. Petruff, Chas. Pierce, Clem Ryan, and Orville E. Smith.

The association voted to affiliate with NETSDA.

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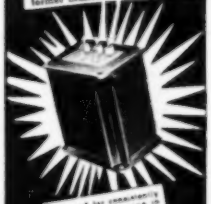

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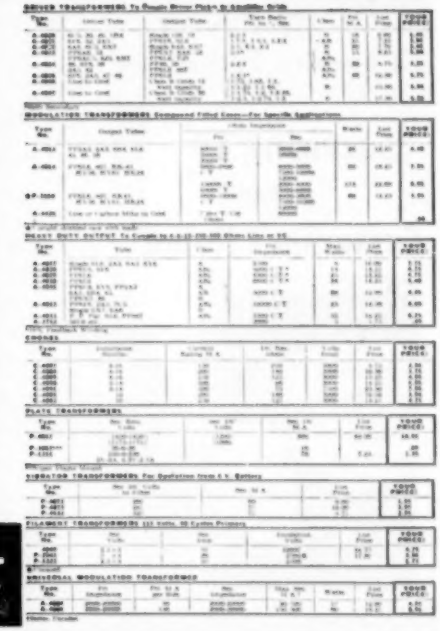

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The circuit is similar to the one published in Audio Engineering Magazine for November, 1949, and is considered by engineers throughout the audio field as one of the best ever developed. The Main Amplifier (which may be purchased separately) consists of a voltage amplifier and phase splitter using a 6SN7, a driver stage using a 6SN7, and a push-pull output stage using a pair of 807 tubes. The output transformer is manufactured by the Peerless Division of Altec Lansing and is built to their highest standards. Output impedances of 4, 8, and 16 ohms are available. The power supply uses a separate chassis with husky Chicago Transformer power transformer and choke, and 700V Mallory sitters for long hum-free operation. A 5V4G rectifier is used.

The main amplifier and power supply are each on a chassis measuring 7" high by 14½" wide by 11" long.

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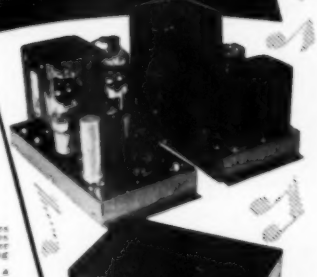

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An SSSC Adapter

(*Continued from page 46*)

from the balanced secondary of L_5. The second balanced modulator receives its excitation from the secondary of L_7 via a balanced 90 degree phase shift network made up of C_{15}, R_{23}, C_{16}, and R_{24}. Each of the condensers has a reactance at 4 mc. equal to 390 ohms, the resistance of each resistor. The 90 degree phase shift between the two excitation voltages is not affected by the tuning of L_7, but rather is dependent on the resistance-to-reactance ratio of the two pairs of resistors and condensers. This type of phase shift network is much more broadband than a tuned type so that the phase shift is close to 90 degrees over the entire phone band.

12AU7's are used as the two balanced modulators with a potentiometer in one cathode lead of each as a fine balancing control to balance the circuit electrically against a fixed resistor in the mirror cathode lead. These two pots are on the front panel of the unit and the balancing adjustment may be accurately made by watching the receiver S-meter and setting the two controls for minimum signal from the transmitter adapter.

Audio voltages are applied to the cathode circuits of the balanced modulators to avoid the requirement of four r.f. chokes to feed the plates separately. This is plate modulation rather than cathode modulation because the grid leak resistors are returned to the modulation transformer secondaries rather than to ground, but the modulation is introduced in the "B—" lead rather than in the "B+" lead as is more commonly done.

The four plates of the balanced modulators are simply connected in parallel and to the common tank circuit comprised of L_7 and C_{25}, where the single-sideband signal appears. Since no carrier is being generated, it is not necessary to apply "B+" to the modulator plates, but a small amount of d.c. is helpful to aid in setting the balance controls. For this reason, the "cold" end of L_7 is returned to the cathodes of the 6AQ5's which are at a suitable potential.

The single-sideband signal is applied to the grid of the class A 6AG7 output amplifier to be amplified to the one-watt level. This stage is operated with cathode degeneration to improve its stability.

If 20-meter operation is desired, it is only necessary to plug in the 20-meter output coil. This coil has a jumper wire to one of the unused pins which applies plate voltage to the harmonic crystal oscillator. The crystal oscillator generates a comparatively large output which is also impressed on the grid of the 6AG7. This results in grid current in the 6AG7 and the tube operates as a linear mixer, generating the beat signal between the 10 mc. crystal oscillator output and the 4 mc. single-sideband to produce a 14

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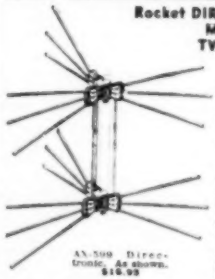

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mc. single-sideband output signal.

Ten mc. rocks are rare and expensive, yet it is highly desirable to use a crystal oscillator for reasons of stability and doubling or tripling to 10 mc. from a lower frequency crystal is not desirable because of the likelihood of passing spurious harmonics through to the output tank. For this reason, a harmonic crystal oscillator was used. In this type of oscillator, the crystal oscillates on the third harmonic of its normal frequency, so that it is possible to use a crystal of approximately one-third the desired output frequency. Although 10 mc. has been used throughout the above discussion for the sake of round numbers, the actual frequency should be closer to 10.3 mc. so that when heterodyning the range of 3900-4000 kc., the output will cover the 20-meter phone band. A suitable crystal would therefore have a fundamental frequency of about 3433 kc. and such crystals are readily obtainable on the surplus market.

A word may be said about the voice-operated relay system using a pair of sensitive relays. By judicious adjustment it is possible to make one relay close a trifle ahead of the other so that the receiver can be silenced before the transmitter is turned on, and two independent circuits may be operated. Double-pole relays of the sensitive type are rather unusual.

The single-sideband adapter has given excellent results on the air in conjunction with its associated amplifier, and has even worked over surprising distances with its one watt peak output coupled directly into the antenna.

REFERENCE

1. Dome, R.B.: "Wideband Phase Shifting Networks," *Electronics*, December, 1946.

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Norgaard: "What About Single-Sideband?" *QST*, May, 1948.

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Nibbe: "Audio Phase-Shift Networks" *QST*, January, 1950.

—30—

"OLD TIMERS' NITE"

THE Delaware Valley Radio Association has scheduled its 8th Annual "Old Timers' Nite Round-up" and banquet for Saturday, April 19th.

The affair will be held in the Grand Ballroom of the Hotel Stacy-Trent, W. State Street at Willow in downtown Trenton, N. J.

Guest speakers will include radio personalities, some of them famous in wireless history. W2ZI's now-famous collection of old time wireless gear will be on display.

Prizes will be awarded to operators who can produce "vintage" commercial and ham tickets. A special award will also be presented to the "Grand OM" whose radio experience dates back to the earliest days of wireless.

Tickets to this STAG affair are available from Ed G. Raser, W2ZI, general chairman of the event. —30—

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- **Use regular oscilloscope for stage-by-stage alignment of TV receiver.**

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NEW TV PRODUCTS on the Market

NEW TUBE FOR TV

The Tube Department of the *General Electric Company*, Syracuse, New York, has announced the availability of a new tube which has been designed to reduce vertical distortion on television receivers which are operated from a low "B plus" supply voltage.

The new tube, type number 6BX7-GT, is a twin triode designed for the vertical output stage of television receivers as a combined vertical deflection amplifier and vertical oscillator.

It is designed to provide better linearity and more sweep at a lower driving voltage. Because it will operate at a lower voltage, use of the tube will also result in a saving of transformer copper.

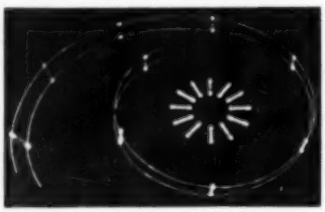
Among typical operating characteristics for each section are a cut-off voltage of 40 volts with 250 volts on the plate and 80 ma. plate current at zero bias with 100 volts on the plate. The new tube has a maximum plate supply voltage rating of 500 volts as a vertical deflection amplifier.

"FRETLINE"

Fretco Television Company, 1041 Forbes Street, Pittsburgh 19, Pa., has made a new improvement on its open wire transmission line.

"Fretline" is now being manufactured with a newly-designed insulator made of clear, prime virgin polystyrene. Because all coloring matter has been eliminated from this insulator, the line shows less loss and improper impedance than other types, according to the company.

The wire used in the new "Fretline"



is hard drawn with precision tolerance and will hold its shape even after extensive exposure to salt spray.

A data sheet covering this new product is available from the company on request.

IGNITION FILTER

Telematic Industries, Inc., 1 Joralemon Street, Brooklyn, New York, has added a new ignition filter to its line of TV service accessories.

The WT-28 filter is designed to eliminate or reduce ignition interference from TV receivers. This unit is an antenna feeder filter tuned to ignition frequency peaks and consists of a resonant shunt inductance and a series line capacitance which offer extremely high attenuation to ignition interference.

The unit is housed in a compact shielded case which can be installed at the antenna terminals of the receiver.

THERMO RELAY

A new automatic thermo relay is currently being offered by *B-T Manufacturing Corporation*, 38 N. Second Avenue, Mt. Vernon, New York.

Designated as Model TR-2, this unit will control equipment drawing up to .5 amp at 117 volts and a wide range of actuating currents. The time delay is adjustable from $\frac{1}{10}$th to 4 seconds. The construction is rugged and simple and the unit uses contacts of fine silver. Over-all length is $2\frac{3}{8}$".

This unit has many applications in television and electronics where auxiliary switching and/or time delay are to be accomplished inexpensively.

"SPACELINE"

Clearbeam TV Antennas and Accessories, Burbank, California, is now marketing a new and improved type of TV twin-lead which is said to eliminate at least 50 per-cent of the signal loss.

"Spaceline" is made of a tough 20-gauge copper wire and pure 55 mil polyethelyne. In this line, by eliminating a substantial portion of the polyethelyne and substituting air for insulation, *Clearbeam* engineers have cut TV signal loss by at least half.

The new lead-in is now available at jobbers in 1000 foot spools.

NEW INDOOR ANTENNA

Snyder Manufacturing Company of 2218 W. Ontario Street, Philadelphia, Pa., is now in production on its new indoor "Directronic" TV antenna system.

The new unit embodies the electronic principles and operation of the company's outdoor "Directronic" introduced last year. The indoor "Directronic" is an all-channel antenna offering a combination of elements for picture clarity on each channel and full 360 degree orientation without the use

of motors or electric power. A "beam selector," mounted on or near the television set, gives remote control of element combinations.

Instead of rigid elements, this new unit has flexible tape elements which adhere in a horizontal position to any ceiling. The antenna has been designed to be concealed in closets or attics or sealed to the ceiling of a room.

GUY WIRE TIGHTENER

Universal Metal Products Company, 1211 Palmwood Avenue, Toledo 7, Ohio, is currently introducing a new antenna guy wire tightener and lock which has been tradenamed "Universal Guy Lock."

This new item is now available in two models—the Model GL 2 has the mounting screw permanently attached to the chassis while the Model GL 1 is without a screw but has a mounting hole large enough to accommodate any size mounting bolt.

The units replace any size turnbuckle and mounting screw. They are positive locking and provide unlimited take-up and easy equalizing adjustments. The guy wire is easily attached to the shaft and the unit has a rust-resistant plate chromate finish.

A data sheet on the new units is available on request.

PREAMP COUPLER

JFD Manufacturing Co., Inc., 6101 16th Avenue, Brooklyn 4, New York, has developed a "Hide-Away" preamp coupler which will permit the operation of up to 13 receivers from a single antenna without loss of signal strength.

Catalogued as the EC-4, four sets may be operated from each of these units. Video signals are boosted by two r.f. amplifier stages using 6BQ7 tubes.

The "Hide-Away" will be marketed

both for multi-receiver homes and for restaurants, motels, and small hotels where the larger television distribution systems would be economically impractical.

The company will supply complete details on the EC-4 on request.

DISTRIBUTION UNIT

Blonder-Tongue Laboratories, Inc. of 38 North Second Street, Mt. Vernon, New York, is in production on a two-outlet distribution amplifier, the Model DA2-1-M.

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8350	10.0 Henries, .225A., 500V Ins. Westinghouse, Tuttorsell Insulated	4.98

TANK CIRCUIT. 130-200 Mc. Uses 2-826's. In Metal Shield Box, complete w/tubes 7.95 ea.

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Stock No.	Description	Price
1159	Sec #1-630 V.C.T. @ .150A. Sec #2-6.3V @ 2.1A. Sec #3-5V @ 3A Jefferson	$4.95
1160	Sec #1-1450 V.C.T. @ .100A. Sec #2-6.3V @ 1.2A. Sec #3-5V @ 3A Jefferson	5.95
8398	Sec. #1-6.3V @ 10.0A. Sec. #2-6.3V @ 1.5A. Sec. #3-5V @ 3A. Sec. #4-800V @ 141 M.A.C. Westinghouse Tuttorsell Insulated	7.95
1158	Sec. 4000V @ .025A Jefferson	8.95
1157	Sec #1 4V @ 10.0A. Sec #2-5V @ 1.75A Jefferson	5.75

AUDIO OUTPUT TRANSFORMERS

600 V. Insulation 60 ma primaries. Secondaries match 3.2 ohms terminal.

Stock No.	Primary Impedance	Price Ea.
567	2,000 ohms	$0.49
753	2,400 ohms with hurking winding	.59
243	2,500 ohms	.49
178	2,500 ohms with hurking winding	.59
656	5,000 ohms	.49
174	6,000 ohms	.49
668	8,000 ohms	.49
430	1,100 ohms with hurking winding	.59

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3.5 mfd	220 V.A.C.	.69
4 mfd	3,000 V.D.C.	5.95
6 mfd	1,000 V.D.C.	3.39
7 mfd	220 V.A.C.	1.39
7 mfd	600 V.D.C.	2.69
8 mfd	1,000 V.D.C.	3.69
8 mfd	330 V.A.C.	2.75
10 mfd	1,000 V.D.C.	3.89
12 mfd	600 V.D.C.	3.98
16 mfd	330 V.A.C.	3.98

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4.0 mfd	400 V.D.C., C.D. BM4400	.80

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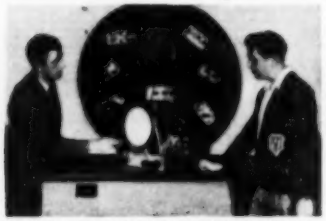

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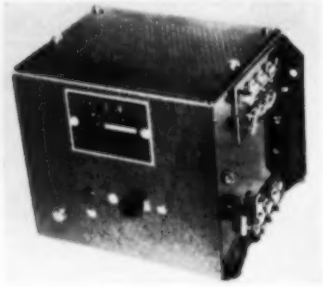
lets and a through-line output, it can be used in master antenna systems of any size or as a complete system for the two-set home. Providing full electronic isolation and amplifying all



channels simultaneously to each TV set, these units may be used in a series by interconnecting them with 75 ohm line. Simple screw terminals provide for speedy, economical installation.

Employing two 6BC5 tubes, the new unit amplifies all channels without loss to each TV set output and, in addition, has correct impedance matching at each terminal for 75 and 300 ohm lines. Maximum input and output signal voltages are .5 on 75 ohms and 1 volt on 300 ohms.

DUO-CHANNEL YAGI

Channel Master Corp., Napanoch Road, Ellenville, New York, has recently introduced a new two-channel yagi antenna, the "Z-Match" dual yagi, Model 645.

Covering both Channels 4 and 5, this antenna provides a perfect match to 300 ohm line, in both single and stacked arrays. Performance has been improved by new element and reflector lengths, and a single bay gives over 8 db measured gain on each channel. Stacking provides 100% additional gain. Four stacked Model 645's furnish actual gain of over 14 db on each channel, according to the company.

A unique phasing harness keeps the gain flat on both Channels 4 and 5. The antennas have a front-to-back ratio of over 20 db. Complete literature, with technical details, gain curves, and 4-bay stacking information is available on request.

GLARE FILTER

T.V. Development Corp. of 2024 McDonald Avenue, Brooklyn 23, N. Y., has recently introduced a television glare filter which has been tradenamed the "Vision-ease."

The new filter comes in either blue or smoke and is scientifically designed to protect eyes from fatiguing glare. According to the company it increases definition and contrast under any lighting condition.

Filters are easily attached to any television receiver by means of the double-face adhesive supplied with each unit. They come in an assortment of sizes to accommodate tubes from 10

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through 21 inches. Each filter is individually boxed.

Copies of the data sheet covering these various filter models are available on request.

PIVOTING TV TOWER

Tel-a-Ray Enterprises, Inc., Box 332, Henderson, Kentucky, has developed a new television tower that pivots in the middle and swings over to the ground for servicing.

The new "Swing-Over Tower" is of steel angle and welded construction and guaranteed against weather damage. It is available in two models—a 50 foot unit for mounting in concrete in the ground (without guy wires) and a 24 foot house-top model.

Both models incorporate the exclusive "swing-over" feature that permits the top of the tower to be lowered to the ground or roof. Field tests show that one man can raise or lower the tower in three minutes.

GROUND RESISTANCE TESTER

Borden Engineering Co., New Providence, New Jersey, has developed a new lightweight, low cost ground resistance tester which has been designed especially for radio and television installation and service technicians.

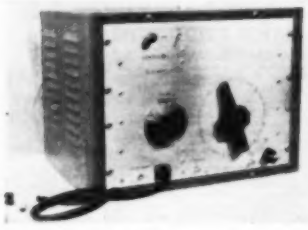
Known as the "Type Z Groundometer," this new unit measures the resistance to earth of ground rods, water pipes, etc. It is direct reading over three ranges, 10, 100, and 1000 ohms full scale. The instrument comes complete with 10" duplex reference probes on which are wound the three test leads of proper length for the correct spacings.

Complete instructions for the installation and grounding of radio and TV antenna masts is included in Bulletin #180 which accompanies the unit.

TEST INSTRUMENT

The Electronics Division of *General Electric Company*, Syracuse, New York, has recently introduced a new combination sweep and marker generator designed primarily for factory use.

The Model ST-11A is a TV channel sweep combining sweep signal and



markers for r.f. alignment of television head-ends and over-all systems. Its rugged and simple design, incorporating only two controls, make it ideal for factory use.

It features single-knob selection of sweep and from one to five marker fre-

WHAT TO BUY and WHAT TO DO with
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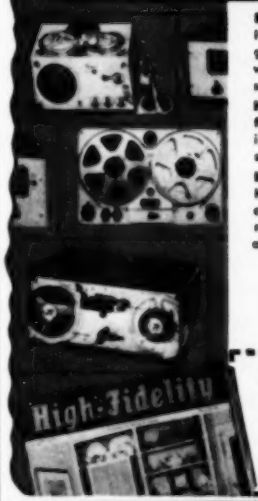

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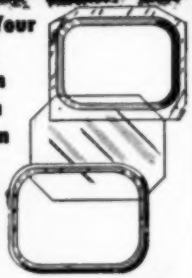

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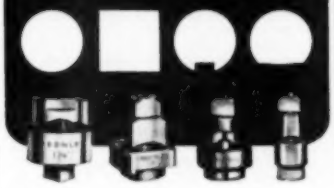

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NEW YAGI ANTENNA

LaPointe-Plascomold Corp., Windsor Locks, Conn., has introduced a new antenna in its "Vee-D-X" line, the "Long John."

The new unit is an 8-element yagi which is said to provide up to 41 percent gain over 5-element yagis. The antenna has been designed to be used with the company's "Rocket" booster to provide improved fringe area reception. The booster is a single-channel, mast-mounted model that boosts the signal before line loss occurs and before line noise is picked up.

In combination, these new units are said to help eliminate snow and flop-over, both of which have been major obstacles to fringe area selling.

TV LENSES

Ercona Camera Corp., 527 Fifth Ave., New York 17, N. Y. has announced the availability of a new line of Zeiss lenses for TV cameras.

At present the lenses are only being produced with *RCA* mounts but *Du Mont*, *G-E*, and *General Precision* mounts will be available shortly.

The line includes focal lengths from 1 to 14 inches. The company will supply full details on request. —30—

To keep Africans living in the remote villages of the Gold Coast's Northern Territories informed of events in the country, experiments are being carried out with a loudspeaker system called the Rediffusion Kiosk. The Kiosk is a strongly-built, modern-looking structure standing six feet high and built of reinforced concrete with slatted wooden front. Inside is a battery-operated short-wave receiver with a specially made speaker horn, designed to provide good audibility to a crowd of up to 50 persons. The Kiosk is switched on by a voluntary attendant for a few hours during the best listening times and is normally tuned to Accra, Gold Coast stations.

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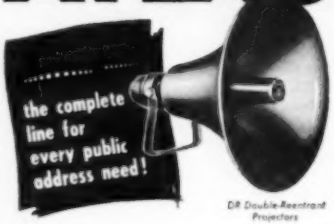

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Technical BOOKS

"THE RECORDING AND REPRODUCTION OF SOUND" by Oliver Read, Editor of RADIO & TELEVISION NEWS and RADIO-ELECTRONIC ENGINEERING. Published by Howard W. Sams & Co., Inc., Indianapolis 5, Ind. 790 pages, 700 illustrations. $7.95. Second Edition.

The first edition of this book was a best-seller in its field, and justifiably earned the title of the "Audioman's Bible." This second edition has been vastly expanded and revised to provide even greater coverage of the field, and to add much new information, bringing the reader up-to-date on all recent significant developments in audio. It is written in a free and easy style with a minimum of mathematics, making the material readable and easy to understand.

In addition to discussing basic concepts on all aspects of audio, the volume presents a wealth of practical information on magnetic and disc recording and reproduction, microphones, amplifiers, tone control and equalizer circuits, complete music and p.a. systems, loudspeakers and enclosures, acoustics, and audio measurements. Every conceivable facet of the audio field is covered for both hobbyist and engineer.

The last chapter presents the NARTB recording and reproducing standards, and the appendix gives much valuable information in the form of mathematical tables, formulas, charts, nomographs, color codes, and a bibliography on magnetic recording.

Here is a volume which every audio hobbyist and engineer should have on his bookshelf.

• • •

"MOST-OFTEN-NEEDED 1952 TELEVISION SERVICING INFORMATION" compiled by M. N. Beitman. Published by *Supreme Publications*, Chicago. 192 pages. Price $3.00. Volume TV-6. Paper bound.

This newest edition of a familiar servicing handbook contains circuit diagrams and essential service data on the current receivers of thirty television manufacturers.

As was the case with previous editions, this manual carries special service notes, television alignment procedure data, various adjustment and alignment details, and a complete schematic diagram of the receiver in question.

• • •

"RADIO AND TELEVISION TV RECEIVER TROUBLESHOOTING AND REPAIR" by Alfred A. Ghirardi and J. Richard Johnson. Published by *Rinehart Books, Inc.*, New York. 795 pages. Price $6.75.

This encyclopedic work for the technician contains all of the information required to identify, locate, and repair defects in radio and television receivers. While the authors have assumed

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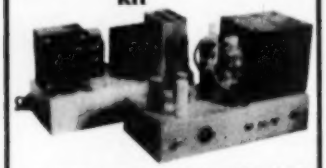

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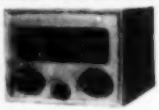

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that the technician using this text has a basic knowledge of electricity, electronics, and receiver circuitry, they have provided all of the other specialized data required in receiver servicing.

A clearcut and practical approach to the problems of servicing characterizes this text. The style is clear and simple and the language is straightforward and nonmathematical. Step-by-step procedures have been favored in the text material in order to assist the technician in tracking down the service fault. Approximately 400 illustrations have been used to amplify the reading material.

The first chapter of the text is devoted to a description of the various components that go into a modern receiver and an analysis of the circuit faults that can be attributed to a breakdown of these parts. The balance of the book covers troubleshooting methods and the various servicing techniques employed in repairing radios, television sets, record players, loudspeakers, and home recorders.

Each chapter concludes with a summary of the material covered and a list of review questions by means of which the student can check his grasp of the subject matter.

Technicians will find this a useful and up-to-date companion to their copies of the author's "Modern Radio Servicing," which originally appeared some ten years ago.

• • •

"HOW TO PASS RADIO LICENSE EXAMINATIONS" by Charles E. Drew. Published by *John Wiley & Sons, Inc.*, New York. 367 pages. Price $4.50. Paper bound. Third Edition.

This is an up-to-date handbook for those persons preparing for any of the FCC radio operator's licenses with the exception of the examinations in aircraft radio-telegraph and ship radar techniques.

This book covers elements 1 through 6 in question-and-answer form with the answers being given in the same concise form as required in the examination. The elements covered include basic law, basic operating practice, basic radiotelephone, advanced radiotelephone, radiotelegraph operating practice, and advance radiotelegraph.

In addition, the text includes four appendices which carry data on the FCC and its rules governing commercial radio operators, extracts from radio laws, "Q" code and abbreviations, and miscellaneous but pertinent data.

This book is not intended to supplant regular textbooks on the subjects covered but is a supplementary work dealing specifically with those subjects upon which the FCC examinations are based.

• • •

"TELEVISION FACTBOOK No. 14" compiled by Television Digest Staff. Published by *Television Digest*, Washington, D. C. 112 pages. Price $5.00.

This new edition is the 14th in *"Television Digest's"* semi-annual se-

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ries. This compact and comprehensive handbook includes data on personnel and facilities of all networks and of the 109 TV stations already licensed, along with a complete listing of actual and projected TV stations in Canada, Mexico, Cuba, and South America.

A tabulation of the 479 applications for new TV stations pending before the FCC is also given. TV-radio production figures, sets-in-use, and market data on TV and other areas of the United States have been included along with a 34 x 24 inch wall map in color showing present TV areas and actual and projected coaxial-microwave network routes used for television transmissions.

In addition, the editors have reproduced the full text of the "Code of Television Practices" and have listed television program sources, and the national sales representatives of TV stations.

Complete directories of TV receiver manufacturers, the FCC, Congressional Committees handling TV-radio matters, consulting engineers, attorneys specializing in TV-radio, the NPA Electronics Division, etc., complete this fact-filled handbook.

* * *

"PRINCIPLES OF RADIO" by Keith Henney and Glen A. Richardson. Published by *John Wiley & Sons, Inc.*, New York. 641 pages. Price $5.50. Sixth Edition.

This is a completely revised and rewritten version of the Fifth Edition which appeared in 1945. In the seven years that have elapsed since the previous edition made its appearance many changes have taken place in the radio field and it is in the interest of covering these vital points that this newest edition has been prepared by the authors.

Like the earlier versions, this book has been written so simply that the student studying alone can understand the material without recourse to other texts. This edition includes chapters on fundamentals, d.c. circuits, electrical meters and measurements, magnetism and electromagnetism, inductance, capacitance, properties of a.c. circuits, resonance, properties of coils and condensers, vacuum tubes, the tube as an amplifier, rectifiers and power supplies, audio amplifiers, detection of AM signals, AM receiver systems, oscillators, AM transmitters, transmission lines, antennas and electromagnetic radiation, FM and detection, u.h.f. phenomena, electronic instruments, transients and wave shaping circuits, television, and radar equipment.

The new text features a large number of practical problems and has many of the circuit problems worked out in detail to assist the student in checking his grasp of the subject matter involved.

As a one-volume "library" on the subject of radio, this book would be hard to beat.

—30—

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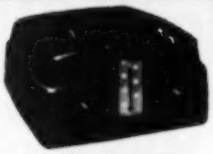

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ceiver manufacturers, as suggested in Fig. 8, to immunize the blocking oscillator against minor circuit disturbances such as power supply variations and thermal noise in the resistors and tubes. The operation of a ringing coil was explained earlier in this article. To adjust the ringing coil, a scope should be used. The usual pattern to be sought when a gated control tube is used is shown in Fig. 8B.

Origin of Noise

Noise which arrives at the horizontal a.f.c. circuits has two possible origins. A portion of the noise is received with the signal at the antenna (or may be picked up by the down-lead), and the remainder of the noise is generated in the r.f. tuner. You can distinguish between the two sources of noise by disconnecting the antenna lead and comparing the amount of snow in this raster with the amount observed before disconnection. If the receiver noise is excessive, try changing the r.f. and mixer tubes. Overheated load resistors in the r.f. and mixer stages will contribute more noise than cool-running resistors.

If the down-lead contributes excessive noise, as determined by disconnecting the lead from the antenna and testing the contribution of the lead as above, try using shielded cable from the antenna to the receiver.

Boosters provide a better signal-to-noise ratio when installed at the antenna, other things being equal, because once a signal has been allowed to fall to the noise level, no amount of amplification can recover the signal.

The amount of noise which gets through an amplifier is directly proportional to the bandwidth. If the signal-to-noise ratio is low, realign the receiver for one-half normal bandwidth and shift the center frequency of the picture amplifier to place the picture carrier near the top of the response curve. Do not try to compensate the i.f. curve deficiencies by adjustment of the r.f. and mixer circuits, as this will lower the signal-to-noise ratio; it is important to obtain uniform band response in both the r.f. and i.f. circuits.

Contributing Factors

Wide fluctuations of line voltage, often encountered in rural areas, contribute to unstable synchronization. Accompanying symptoms of line-voltage variation are changing focus, changing picture width, and some variation in brightness. The sync can be stabilized in such cases by use of a line regulating transformer.

Occasionally power lines are excessively noisy, causing loss of sync. Attention should be given to antenna placement, power-line filtering, lead-in shielding, and, if possible, suppression of the man-made noise at its source.

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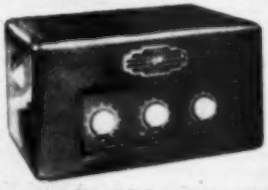

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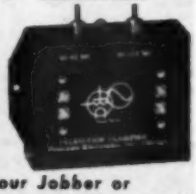

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Noise is occasionally generated in the receiver itself, due to minute corona discharges in the high-voltage system, or to defective connections with fluctuating contact resistance.

Some sync systems require neutralization to avoid instability, or actual oscillation, termed "squegging." Such neutralization may consist of a critical spacing between a pair of condensers and their leads. It should be observed that nearly all noise-rejection systems involve feedback control, and that suitable means are taken in the design and/or adjustment of the circuit to avoid over-control or regeneration.

Flywheel Noise Rejector

The one type of noise rejector which does not utilize feedback control principles makes use of an electrical flywheel. If the sync pulses are developed across a plate load which consists of a properly tuned ringing coil, the tuned coil will generate a sine wave voltage across its terminals. The frequency of this voltage is independent of the presence of random noise voltages, provided the "Q" of the coil is high. This sine-wave voltage is, therefore, utilized as a trigger voltage for the horizontal oscillator, which is thereby effectively immunized against noise.

The efficiency of noise rejection obtained in this system is directly proportional to the "Q" of the ringing coil. If greater noise rejection is desired, the value of the shunt resistor across the coil can be increased. However, a higher "Q" results in greater phase shift of the ringing voltage if the frequency (phase) of the transmitted sync is not quite constant, and the result is a noticeable change in horizontal centering of the picture.

A compromise must thus be made between the desired degree of noise rejection, stability of the transmitted sync, and tolerable drift of the picture. This can be determined only by experiment.

—30—

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—30—

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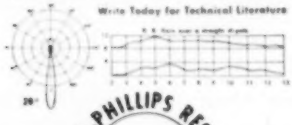

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Mac's Service Shop

(Continued from page 64)

manded. "Why he scarcely knows enough about surgery to cut his own fingernails. You know he would never be allowed to publish the book. It would be murder!"

Barney strode slowly and deliberately over to the wall calendar and with a circling thumb and forefinger ringed the date: April 1st. "April Fool, Matilda!" he shouted as his face broke into a delighted grin.

"You mean there are no books like that about television?" she asked with a suddenly rose complexion.

"No, I mean I was just joshing about writing a book myself. I was not kidding about the fix-it-yourself books on television."

"I've seen some of those books myself," Mac broke in; "and the better ones are not really too awful. They do not encourage the set-owner to take the back off the set at all. About all they do is tell how the size and linearity controls can be used to correct minor picture defects and to give some pointers on orienting the antenna to get rid of ghosts, etc. When more than this is required, they recommend that a technician be called.

"On the other hand a few books are appearing that attack technicians as being crooks and gougers and blatantly assure the set-owner that he can repair practically anything that goes wrong with the set without the use of instruments. That, of course, is a deliberate misrepresentation. The fact that a money-back guarantee is given with some of these books does not change this fact in the least. That money-back business is an old dodge that takes advantage of the fact that not one person in a hundred will bother to return a low-cost item for a refund even though he is not satisfied with it."

"I don't imagine you are much concerned with the business that the sale of these books will take away from technicians, are you?" Barney wanted to know.

"Not at all," Mac replied quickly. "As you know, after the guy has fouled his set up but good, he will call us; and then we shall follow our established policy of upping the tariff sharply for working on a set that shows definite evidence of having been tampered with. As I have explained to you before, we do not do this with any idea of 'punishing' the owner for trying to do his own repair work. It is simply to pay us for the extra time experience has shown will be necessary to repair and thoroughly check a receiver when a natural set failure has been aggravated and complicated by untrained tinkering."

"Well," Barney said as he started for the service room, "since I have decided not to write that book, perhaps I had better start doing a little work for that million."

"That's not a bad idea," Mac agreed

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as he followed him; "but if you really do want to make a lot of money, I can give you an idea to be thinking about."

"I'm all ears; let's have it."

"Well, you start thinking of a good use to which you can put these TV towers after the necessity for them has gone. As more and more TV stations come on the air and fringe areas cease to be fringe areas, these towers are going to start coming down. Then a man will be able to pick them up, I figure, just for dismantling them. Now if you can think of a really practical use to which you can put these light, sturdy, long-lasting sections of tower, you will really be in business. About all I have come up with so far are rose trellises and grape arbors; but I am sure that a sharp character like yourself, with an imagination equal to that of Baron Munchausen, will be able to do much better than that."

"Um-m-m-m," Barney said as he pulled thoughtfully at an ear lobe, "I believe you've really got yourself an idea there. For a while, of course, a guy could dismantle the towers in an area where a new TV station started up and resell them in other fringe areas, but the sections are so bulky and hard to transport that such a plan would not be very practical. I guess I'll have to dream up a really super on-the-spot conversion for them."

"I'll be eagerly awaiting to hear about that," Mac promised as he switched on the bench lights and picked up his solder gun. —30—

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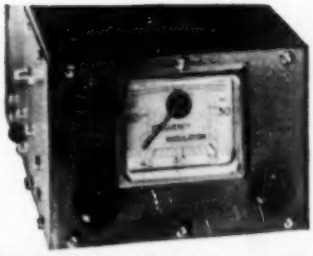
For special purposes a no-load voltage of about 18 volts may be obtained by turning the armature at 1600 rpm. —30—



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1A5G	1.10	6BA7	1.40	304-TL	8.95
1N21	.80	6BG6GT	.70	807	1.00
1N21-B	3.00	6C4	.65	813	9.95
1N22	3.00	6C5	.65	872-A	4.00
1N23	3.00	6C6	.75	954	.65
1N23-A	3.00	6C8G	.90	955	.65
1N23-B	3.75	6D7	.98	1602	9.95
1P21	.60	6E5-C	.98	1616	.75
1S2-A	.60	6H6	.75	1634	1.40
2C34	.75	6J5	.75	1635	.75
2D21	2.00	6J7	.95	1638	.95
2E26	3.25	6K7	.98	2050	1.50
2J2	3.00	6L7	.98	2050A	1.50
2AP1	10.75	6Q7	.80	2051	1.25
2BP1	10.00	6Q7GT	.80	2051-A	1.25
3BP1	10.00	6S7	.98	5510	.75
3D6	.75	6SA7	.98	5516	.75
3D6GT	1.00	6SA7GT	.98	9005	1.50
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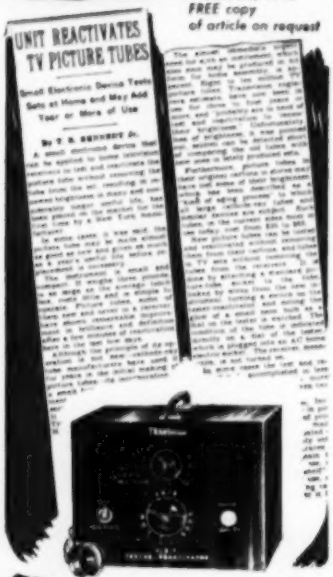

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Junction Transistor

(*Continued from page 39*)

practically no heat loss, making it useful in applications where very large numbers are required, such as electronic computers of various kinds. It is extremely rugged, reliable, and has an almost indefinite life. A typical value of transconductance is 33,000 micromhos per milliampere, and of amplification factor, 39,000. Since the output impedance of a cathode follower is $1/G_m$, an output impedance of 5 ohms is possible with a current of 5 ma. The G_m is inversely proportional to the absolute temperature, so that fantastically large values can be achieved by supercooling. Its noise figure is better than some vacuum tubes, being as low as 10 db and less on some of the units which have been tested.

These characteristics are certainly sufficient to justify the excitement and anticipation brought about by the announcement that such a device had been developed. Lest anyone be misled, it would be well to emphasize that this device is *not* commercially available at the present time, but commercial production is definitely planned for the near future. —30—

WALKER HEADS FCC

PAUL A. WALKER has been named to the post of chairman of the FCC, succeeding Wayne Coy who resigned recently to accept a position in private industry.

Mr. Walker has served as vice-chairman of the Commission since 1945 and a member of the Commission since its inception in 1934. —30—

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ERRATA

In Fig. 2, page 39 of the February 1952 issue ("A High-Quality Audio Amplifier") resistor R should be omitted from the circuit entirely. The B plus lead should connect to pin 8 of V_{1c}. CH should be 25 hy., 20 ma. rating. Use the smallest available size. For C_1, C_2, C_{10}, C_{11} a 500 v. rating is adequate.

* * *

The parts list accompanying Fig. 3, page 51 of the February issue ("A High Gain Signal Tracer-Amplifier") contains an error. T_1 should be a 300-0-300 volt unit instead of the 150-0-150 volt unit specified.

* * *

In the January issue, the coil table on page 41 ("A Vacuum Tube Keyed Transmitter") doesn't specify the winding length for L_1 when used on 80 meters. This figure should be 1 inch.

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2C40	8.90	Highest		7C5	.79
3A4GT	1.55	Prices		7N7	.79
3C23	8.95			7Z4	.79
3B4	.75			12AL5	.79
3S4	.79	6C8G	91.39	12AH7GT	1.10
4E27	10.50	6C9A	2.40	12AT6	.69
5BP1	4.50	6CB6	.90	12AT7	1.19
5Y4	1.98	6F8G	.99	12AU7	.99
5V4G	1.10	6G6G	1.10	12AV6	.69
5Y3GT	.52	6H6	.70	12BA6	.79
5Y4G	.75	6J5	.55	12BC8	.79
6J3	.85	6K6GT	.55	12BH6	.79
6A3	1.49	6K7	.99	12J5GT	.85
6A8?	1.29	6K8	.79	12SA8	.89
6AC7	.99	6K8G	.99	12SA7	.79
6AG5	.99	6L6G	1.25	12SC7	.89
6AG7	1.39	6L7	1.10	12SF7	.69
6AH6	1.45	6N7	1.10	12SF7	.89
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1R5	.87	6BA7	1.16	6SQ7	.72	12SQ7	.68
1S5	.82	6BC5	.86	6T8	1.19	14A7	1.03
1S5	.79	6BE6	.82	6V6GT	.86	14B6	1.03
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3Q4	.89	6BQ6	1.44	6X5	.74	25W4	.88
3Q5	1.02	6C4	.76	7C5	.89	35L6	.86
5U4	.65	6CB6	.86	7F7	.93	35W4	.58
5V4	1.10	6CD6	2.19	7N7	.99	35Y4	.86
5Y3	.67	6F6	.88	7Z4	.84	35Z5	.57
6AB7	1.39	6J5	.76	12AT6	.65	50A5	.95
6AC7	1.21	6J5	.59	12AT7	1.09	50B5	.86
6AG5	.86	6J6	1.09	12AU6	.89	50C5	.86
6AH6	1.49	6J7	.81	12AU7	.96	50L6	.72
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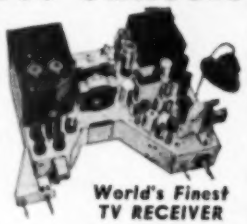

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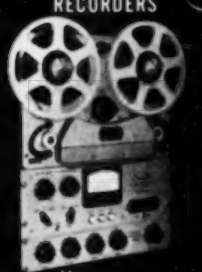

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6617	.30 4	2.00
6617	.30 4	2.00
6586	.30 4	2.00
1106	.30 4	2.00
4	.30 4	2.00
6617	.30 4	2.00
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1	3AG	.03	.25	2.95
2	3AG	.03	.25	2.95
3	3AG	.03	.25	2.95
4	3AG	.03	.25	2.95
5	3AG	.03	.25	2.95
10	3AG	.03	.25	2.95
15	3AG	.03	.25	2.95
20	3AG	.03	.25	2.95
1	4AG	.05	.40	2.95
4	4AG	.05	.40	2.95
10	4AG	.05	.40	2.95
15	4AG	.05	.40	2.95
20	4AG	.05	.40	2.95
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APRIL 1952

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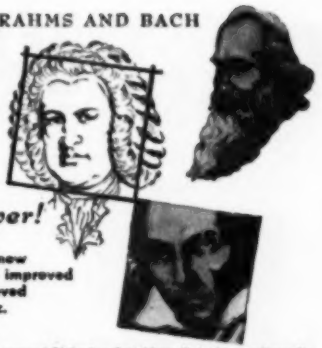

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0B3/VR90	1.23	2C30	3.19	6AK5	.90
0C3/VR105	1.20	2J21	10.69	6AK5W	2.98
0D3/VR150	.98	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

6ST7	1.33	12BE6	.89	34	.69	FG104	37.00
6SU7GTY	3.37	12BF6	.85	35/51	.89	FG105	16.98
6SZ7	1.05	12BH7	1.29	35A5	.79	VU111	1.45
6T7G	.89	12BY7	1.35	35B5	.79	HY114B	.75
6T8	1.09	12BZ7	1.25	35C5	.69	HY115/145	.79
6U4/6AX4	.79	12C8	1.39	35L6GT	.79	117L/M7GT	1.59
6AU4GT	.89	12F5GT	.79	35T	4.89	117N7GT	1.79
6U5/6G5	.89	12H6	.89	35TG	3.45	117P7GT	1.39
6U6GT	1.09	12J5GT	.89	35W4	.69	117Z3	.89
6U7G	.89	12J7GT	.89	35Y4	.69	117Z4GT	1.39
6V3	1.89	12K7GT	.89	35Z3	.79	117Z6GT	1.19
6V6	2.25	12K8	.99	35Z4GT	.69	117Z7GT	1.49
6V6GT	.89	12Q7GT	.79	35Z5GT	.59	F123A	7.90
6V8	1.99	12SA7	.98	REL36/6J4	.49	T125	12.49
6W4GT	.89	12SA7GT	.89	36	.65	F127A	19.90
6W6GT	.89	12SC7	1.19	37	.69	VT127A	3.90
6W7G	1.33	12SF5GT	.79	38	.89	CV148	4.98
6X4	.89	12SF7GT	.59	RK39	2.89	150T	14.50
6X5GT	.75	12SG7	.89	39/44	.89	VT158	14.49
6Y6G	1.27	12SH7	1.10	CRC40	.99	FG166	49.00
6Y7G	.89	12SJ7GT	.75	HY40Z	3.75	FG172	42.50
6Z7G	.89	12SK7	.89	T40	4.29	1828	1.20

WL578	10.49	954	.27
WL579B	12.98	955	.39
801A	.29	956	.36
HY615	.75	957	.45
616	37.00	958A	.67
RU627	18.00	967/FG17	3.95
WL670A	11.98	973	10.75
WL676	39.95	991	.39
WL677	34.00	FM1000	1.50
701A	5.89	CK1005	.85
702A	3.29	CK1006	3.49
702B	5.98	CK1007	.89
703A	5.98	CK1090	2.69
704A	.98	R1100	5.00
705A/8021	1.98	R1130	12.00
707A	7.90	R1148	1.35
707B	17.49	HY12312	5.39
710A/8011	.95	1612	1.90
713A	.98	1613/6F6X	.89
HL714	3.95	1616	.74
714AY	5.90	1619	.25
715A	6.45	1620	5.75

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6ZY5G	.89	12SL7GT	.79	TZ40	3.98	FG190	12.80	715B	8.98
7A4/XXL	.89	12SN7GT	.89	40	1.09	T200	22.98	715C	22.90
7A5	.96	12SQ7GT	.79	41	.79	201A		717A	1.49
7A6	.79	12SR7	.98	42	.69	CX301A	.98	718BY	48.45
7A7	.90	12X3	.90	43	.85	203A	5.98	718CY	48.45
7A8	.99	12Z3	.89	45	.69	205B/VT2	1.69	719A	49.95
7AD7	1.49	14A4	1.09	45S/VT52	.85	CE206	3.15	721A	2.49
7AF7	.99	14A7/12B7	.99	45Z3	.89	211/VT4C	.45	722A/287	2.45
7AG7	1.09	14AF7/XXD	1.19	45Z5GT	.89	CK215	8.98	723A	6.75
7AH7	1.19	14B6	.99	46	.99	RX215	9.95	723A/B	19.95
7B4	.75	14B8	.89	47	.99	WE215A	.18	724A	3.95
7B5	.75	14C5	1.09	48	1.90	217C	8.75	724B	3.45
7B6	.79	14C7	1.09	RK48A	14.85	227A	4.98	725A	6.90
7B7	.89	14E6	.99	RK49	7.80	231	1.20	726A	6.90
7B8	.89	14E7	1.09	49	.81	242C	3.95	726B	59.95
7C4/1203A	.79	14F7	1.09	50	3.19	244A	4.15	726C	69.95
7C5	.98	14F8	1.29	EF50	.98	247A	5.95	800	1.85
7C6	.99	14H7	.99	50A5	1.19	249B	3.75	801A	.45
7C7	1.49	14J7	1.19	50B5	.79	250R	9.90	802	3.98
7C23	72.00	14N7	1.49	50C5	.60	250TH	22.25	803	3.89
7C24	69.95	14Q7	1.09	50C6	1.49	250TL	16.50	804	8.95
7E5/1201	1.29	14R7	1.19	50L6GT	.69	HK254	14.49	805	3.90
7E6	.89	14S7	1.09	50X6	.89	262B	3.98	807	1.65
7E7	.89	14W7	1.09	50Y6GT	.79	274B	3.45	808	2.98
7F7	1.25	14X7	1.33	50Z7G	.98	276A	9.89	809	2.43
7F8	2.19	15E	1.98	52	.99	T300	26.98	810	10.98
7G7/1232	1.29	15R	.89	53	.89	304TH	9.75	811	2.90
7H7	.89	FG17	3.95	T55	8.79	304TL	9.80	812	3.70
7J7	1.09	18	.98	55	1.06	307A/RK75	4.85	813	7.83
7K7	1.29	19	.89	56	.85	310A	6.25	814	3.45
7L7	1.19	19BG6G	1.79	57	.79	311A	7.45	815	2.4
7N7	1.19	19T8	1.09	58	.79	311CH	10.95	816/866Jr.	1.0
7Q7	.79	19V8	1.62	59	1.78	311YC	10.50	826	.95

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7R7	.99	T20V/1623	3.79	T60	10.49	313C	2.98	828	11.29
7S7	1.09	TUF20	5.19	HY69	4.98	316A	1.49	829	11.49
7T7	1.03	TZ2-	3.79	70A7	1.59	318T	10.50	829B	13.49
7V7	1.39	RK20A	8.95	V70D	4.45	323A	24.25	830B	3.49
7W7	1.19	20	1.17	70L7GT	1.59	327A	4.95	832	9.85
7X7/XXFM	1.19	RX21	3.75	71A	.79	350A	6.50	832A	9.85
7Y4	.89	22	.89	72	.95	350B	5.90	833A	39.45
7Z4	.89	24	.85	CRP72	1.20	353A	4.63	834	5.95
10C-15	4.98	24A	1.10	CRP73	1.49	HK354	24.98	836	4.75
10Y	.43	24G/3C24	1.90	73	1.67	355A	14.15	837	1.45
CV11	5.25	25A6	1.09	NR74	.29	368AS	7.75	838	3.98
UXCV11	5.25	25A7	2.98	HY75	4.55	371B	.90	841	.39
12A	.89	25AC5GT	1.59	75	.99	380A	.79	845	4.90
12A5	1.39	25AV5GT	1.29	75TL	6.89	388A	1.49	849	29.45
12A6	.89	25BQ6GY	1.19	76	.79	393A	6.90	852	19.98
12A7	1.29	25C6	1.18	77	.69	394A	4.90	860	4.90
12A8GT	.79	25L6GT	.69	78	1.05	FP400	15.98	861	23.95
12AC7	1.48	25W4GT	.89	79	.99	X400	14.98	864	.39
12AH7GT	1.09	25Y5	.79	80	.69	417A	8.95	865	1.29
12AK5	1.98	25Z5	.79	81	1.69	GL434A	29.95	866A	1.69
12AK5W	2.98	25Z6GT	.90	FG81A	3.90	446/2C40	1.89	866/CE1C	3.49
12AL5	1.11	26	.79	82	1.19	446B	3.89	869	36.95
12AT6	.59	27	.69	82V	1.39	450TH	44.00	872A	1.89
12AT7	.93	FG27A	8.70	83	1.45	450TL	47.00	GE872A	5.49
12AU6	.89	HY27	10.95	83V	1.79	460		874	1.39
12AU7	.74	RK28A	4.89	84/6Z4	.90	HF200	15.95	876	1.95
12AV6	.69	28D7	1.39	85-	.79	WL469	13.95	884/6Q5G	1.90
12AV7	1.35	30	.79	89	.75	GL471A	2.69	885	1.45
12AW6	1.79	31	.59	VR92	.28	GL502A	1.79	893A	250.00
12AX4GT	1.20	HY312	3.75	FG95/5560	24.85	RH507	9.98	922	1.75
12AX7	.99	32	.49	FG98	19.95	GL520	32.00	923	1.00
12AY7	2.95	FG32/5558	12.85	100TH	8.85	521	6.98	927/CE25	1.49
12BA6	.79	32L7GT	1.49	102D	2.98	WL532	3.89	929	1.33
12BA7	.79	33	.80	102G	2.98	550P1	19.95	930	1.33
12BD6	1.75					575A/673	13.75	931A	6.90

1622	2.69	CK5783	6.69
1624	1.90	CK5784	7.40
1625	.39	CK5829	5.98
1626	.39	CK5851	4.98
1629	.39	CK5875	1.98
1630	.97	**C'Ray Tubes**	
1631	.74	2AP1	11.90
1632	.77	3AP1	10.69
1633	.73	3AP1A	14.25
1634	.73	3BP1	7.19
1635	1.49	3BP1A	14.98
1636	3.19	3CP1	2.20
1644	.85	3DP1	4.85
2000T	140.50	3EP1/900P1	4.98
2050	1.47	3FP7	1.69
2051	1.19	3FP7A	14.98
R4340	36.00	3GP1	4.79
5516	5.98	3HP7	3.85
5517	3.39	3HP14	14.98
5594	6.65	3JP7	12.50
5608A	5.95	3JP12	13.95
5637	7.15	3JP14	16.95
5638	4.79	4AP10	4.69
5651	3.95	5AP1	5.98
5654	1.95	5BP1	4.49
5656	6.95	5BP1A	14.78
5663	1.65	5BP4	4.75
5670	6.98	5CP1	4.75
5684	14.98	5CP7	11.95
5686	3.90	5CP7A	26.25
5687	5.75	5FP7	1.89
5691	7.65	5FP14	18.98
5693	7.65	5HP1	9.75
5694	3.85	5HP4	9.75
5718	10.15	5JP2	24.40
5719	12.75	5JP4	26.75
5726	4.39	5LP1	29.95
5744/CK610CK	6.49	5MP1	9.75
5749	4.30	5NP1	3.85
5751	5.45	7BP1	4.98
5763	1.70	7BP7	6.75
5812	2.98	7EP4	17.98
5814	5.49	7JP4	18.39
5840	12.75	9GP7	14.89
5881	3.29	9LP7	5.98
X6030	4.49	10BP4	18.29
UX6653	.69	12DP7	16.89
8002R	99.50	12DP7A	49.98
8005	6.95	12GP1	49.98
8008	6.49	12GP7	16.89
8012	2.89	12HP7	16.89
8013	2.75	12JP4	27.00
8013A	6.45	12KP4	47.00
8014A	28.93	12LP4	21.25
8020	1.25	902	10.49
8025	5.79	905	3.49
9001	1.65	912	69.98
9002	1.20	913	11.98
9003	1.69	914A	45.00
9004	.42	**Xtal Diodes**	
9005	1.45	Many Late Dates	
9006	.39	Latest JAN Specs	
Sub-Miniatures		1N21	.79
2E36	2.19	1N21A	1.65
2E41	2.39	1N21B	3.45
2E43	1.39	1N21C	27.49
2G21	2.39	1N22	1.25
CK512AX	3.15	1N23	1.39
CK525AX	3.95	1N23A	2.49
CK526AX	3.95	1N23B	3.70
CK571AX	4.98	1N25	7.49
CK573AX	4.45	1N26	9.15
CK1027	3.35	1N27	1.65
CK1026	9.98	1N29	3.98
CK1089	2.98	1N32	24.50
CK1090	2.98	1N34	.64
CK5672	2.29	1N34A	.98
CK5676	2.29	1N35	1.98
CK5678	2.45	1N38	1.69
CK5697	9.98	1N39	8.19
CK5702	7.45	1N40	9.98
CK5703	.98	1N43	1.69
CK5704	4.39	1N44	1.21
		1N45	1.39
		1N46	.69
		1N47	9.50
		1N48	.59
		1N51	.45
		1N52	1.65
		1N54	.69
		1N55	2.99
		1N56	.89
		1N57	.89
		1N58	1.19
		1N60	.69
		1N61	2.19
		1N63/K63	2.49
		1N64	.69
		1N67	1.95
		1N69	1.98
		K34	1.39
		CK705	.77
		CK706	.54
		CK707	1.90

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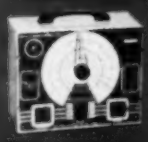

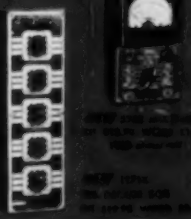

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